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MIND AND BRAIN:

OR,

THE CORRELATIONS OF CONSCIOUSNESS AND ORGANISATION;

WITH THEIR APPLICATIONS TO

PHILOSOPHY, ZOOLOGY, PHYSIOLOGY, MENTAL PATHOLOGY,
AND THE PRACTICE OF MEDICINE.

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CONTENTS OF VOL. II.

PART IV.—PRINCIPLES OF A SCIENTIFIC PSYCHOLOGY.

CHAPTER I.—ON THE SUBSTRATUM OF CONSCIOUS MIND, AND ON THE METHOD OF DETERMINING ITS LAWS IN RELATION TO CONSCIOUSNESS.

Page

Necessary Intuition of a Substratum in which Mind is manifested, ... 2
Implied in all the Phrases of the Metaphysician, . . 3
Doctrine of Material Ideas, ... 4
Correlation of Mechanico-Chemical and Nerve Forces, . 8
Definition of Teleorganic Changes, . . . 9
Nature of Ideagenic and Kinetic Substrata, . . 10
Doctrine of Vital Affinities, ... 13

CHAPTER II.—FUNDAMENTAL CORRELATIONS OF LIFE AND CONSCIOUSNESS.

§ 1. *The Evolution of the "Concrete* Ego."

Fundamental Conscious States, ... 15
The Fundamental Correlation, ... 16

§ 2. *Corporeal Consciousness, and the Range of its Development.*

Doctrine of Reflex Acts—Unzer and Prochaska, . . 19

§ 3. *Is Feeling a Cause of Adapted Movements?*

The Question answered in the Negative, . . . 21

Page
Fallacies of profferd solutions, ... 22
Question of Compound Consciousness, . . . 25
Nature of the *Lex Nostri Conservatio,* . . . 26

CHAPTER III.—CORRELATIONS OF THE DESIRES AND FEELINGS WITH THE LAWS OF VITAL ACTION.

§ 1. *Pleasure and Pain—Titillation.*

§ 2. *Desire in general.*

§ 3. *Special Fundamental Desires—Instinctive Desires.*

Desires as to Good and Evil, ... 34
Derivative Prescient Desires, ... 35

§ 4. *The Desire to Energize.*

Is the fundamental element of Volition, . . . 38
Meaning of "Free Will," 39
Physiological Nature of Instinct, . . . 40

CHAPTER IV.—THE GENERAL LAWS OF EVOLUTION AND MANIFESTATION OF THE MENTAL FACULTIES AS ACTIVE POWERS.

§ 1. *The Cognitive Faculties.*

Apperception, ... 42
Comparison, ... 43
Deduction and Generalisation, . . 44

§ 2. *Presentative and Representative Faculties.*

Representation, ... 45
Imagination and Repetition, ... 47
Orectic Imagination, ... 48
Association of Ideas, ... 49
Association of Ideas as Sympathies, . . . 51
Imitation, ... 52

§ 3. *Volitional Faculties.*

Attention, ... 54

Page
Motor Volition, ... 55
Intellectual Will, ... 57

§ 4. *General Summary.*

CHAPTER V.—FUNDAMENTAL CORRELATIONS OF THE LAWS OF GROWTH AND DEVELOPMENT AND THE LAWS OF THOUGHT.

§ 1. *Evolution of the Organismic Tissues as the Substratum of the Mental Faculties.*

Origin of a Vital Substratum, ... 61
General Law of Manifestation of the Faculties, . . 63

§ 2. *Fundamental Affinities of Organismic Tissues.*

Organismic Waves of Force—Correlative Conscious States, 65

§ 3. *Organismic Evolution of New Instincts and Faculties in the Species.*

§ 4. *Organismic Degradation of Instincts and Faculties.*

CHAPTER VI.—GENERAL DOCTRINES OF THE FACULTIES, FEELINGS, AND BELIEFS, AS EXPERIENCE.

§ 1. *General Summary of the Feelings and Faculties of Experience.*

§ 2. *On the Origin and Nature of some of the Fundamental Beliefs.*

Nature of Belief, ... 82
Belief in Personal Identity, ... 84
In Continued Existence, ... 85
In the Exercise of Power, ... 87
In Cause, Design, and Power over Thought, . . 88

CHAPTER VII.—THE EVOLUTION OF THE INSTINCTS, FACULTIES, AND FEELINGS.

§ 1. *Evolution of Doubt and the Desire to Know.*

Desire to Know or Feel, ... 92
Experience of Time, ... 93

Page

§ 2. *Evolution of the Faculties of Experience.*

Sensational Verification, ... 95
Instinctive Attention, ... 96
Comparison, as Mental Attention, . . . 97
Physiology of Representative Faculty, . . . 98

§ 3. *Evolution of the Egotistic Faculties and Feelings.*

Fundamental Desire of Conservation, . . . 103
Instinctive Curiosity—Caution, ... 104
The Sentiments, ... 105

Chapter VIII.—Fundamental Intuitions as Scientific Ideas, or Causal Ideas of the Sciences.

Fundamental Intuitions, ... 108
Intuitions of Physics and Biology, . . . 110
Intuitions of the Pure Sciences, ... 111
Intuitions of Mechanics, ... 112
Intuitions of the Mechanico-Chemical Sciences, . . 113
Intuitions of Architecture, ... 113
Æsthetical Intuitions, ... 114
Intuitions of the Ludicrous and Grotesque, . . 116
Intuitions of Metaphysics and Ethics, . . . 118

Chapter IX.—The Unity of the Laws of Life and Thought.

Fundamental Desire for Unity, ... 120
Love of the Sexes, ... 121
Love of Offspring, ... 122
Desire for Social Union, ... 125
Desire for Unity of Knowledge, ... 127
Desire for Union with God in this Life, . . 131
And in a Future Life, ... 132

Part V.—PRINCIPLES OF A MENTAL PHYSIOLOGY.

Page
Introduction and Limitation, ... 139

Chapter I.—General Doctrines of the Encephalon as the Seat of the Unifying Processes of Life and Thought.

Unifying Function of Encephalon, . . . 143
Development of the Special from the General in Inquiry, 145
Illustrated by the Natural History of the Hydrozoa, . 147
Law of Differentiation of the Encephalon, . . 151
Physical Characters do not necessarily reveal Vital Tendencies, 153
The Brain a Compound Organ, ... 154

Chapter II.—Historical Review of Researches into the Law of Cerebral Differentiation with Unity of Function.

§ 1. *The Physiognomical Method.*

Founded on a Faculty of Diagnosis, . . . 157
Cranioscopy as a Science and Art, . . . 158

§ 2. *The Anatomical Method.*

Researches of Wallis, ... 161
Era of Prochaska and Gall, ... 164
Modern Doctrines as to Differentiation with Unity, . 171
Conflicting Doctrines reconciled, . . . 174

Chapter III.—Principles of a Physiological Classification of Vital and Mental Phenomena in Correlation.

Causes of Difficulties and Defects in current Classifications, 176
Law of Continuity and Complexity of Phenomena, . 178
Distinction of Plants and Animals, . . . 180
Principles of Teleiotic Homologies, . . . 183

Page

CHAPTER IV.—OUTLINES OF A CLASSIFICATION OF CORRELATIVE MENTAL AND VITAL PHENOMENA.

§ 1. *Primordial Modes of Vital and Mental Energies.*

§ 2. *The Primordial Instincts.*

The Absolute Primordial Instincts, . . . 190
The Relative Primordial Instincts, . . . 191

§ 3. *The Corporeal Instincts and Appetites.*

The Animal Instincts, ... 194
Instincts of External Relation, ... 196
Communistic Instincts, ... 197

§ 4. *The Sentiments and Faculties of Man.*

CHAPTER V.—THE FUNDAMENTAL CORRELATIONS OF THE INSTINCTS AND APPETITES WITH VITAL MOTION.

§ 1. *General Laws of Transference of Vital Force.*

§ 2. *Correlations of Growth and Visible Motion.*

Primary Vital Movements, ... 205
Teleiotic Homologues of Sexual Instincts, . 209

§ 3. *Correlations of Growth and Motion in Aëration and Alimentation.*

Homologies of Corporeal Appetites, . . . 211
Homologies of Maternal Instincts, . . . 213

§ 4. *Correlations of Growth and Motion in the Conservative Instincts and Processes.*

Homologies of Defensive Instincts, . . . 215

CHAPTER VI.—THE NUTRIENT FLUID AND THE BLOOD AS A UNIFYING AND CO-ORDINATING APPARATUS.

§ 1. *Unifying and Co-ordinating Action of the Nutrient* Contenta *of Cells and Vessels.*

Of the *Contenta* of Sperm-cells and Germ-cells, . . 219

Page
Of the *Contenta* of Vessels in Vegetables, . . . 220
Illustrated by the action of Poison on Plants, . 222

§ 2. *Co-ordinating Action of the Blood in relation with the Capillaries and Primary Elements of Nerve-tissues.*

Evolution of the Blood-corpuscle and Blood-vessels, . 223
The Blood as a Co-ordinator of Capillary Action, . . 225
The Nerve in relation to Distribution of the Blood, 225
The Tissues in relation to the Blood, . . 228

CHAPTER VII.—CORRELATION OF THE SYMPATHIES AND ANTIPATHIES WITH THE PRIMORDIAL INSTINCTS.

§ 1. *Correlation of the Visceral or Internal Sympathies with the Primordial Instincts.*

Action of the Blood on the Nerve-centres as a Cause of Appetites, ... 229
Conjoint Influence of the Viscera on the Appetites, . 231
Mode of Influence of the Generative Glands on the Instincts, 232

§ 2. *Correlations of the Organic Sympathies, as Appetites, with Primordial Instincts.*

Unity of Structure and Appetites in Lower Organisms, . 235
Automatic Nature of Instinctive Movements, . 236

§ 3. *Correlations of the Sympathies and Antipathies proper with the Primordial Instincts.*

General considerations as to the Propensities, . . 237
The War-instinct for acquiring Food, . . . 238
Tho War-instinct for Self-defence, . . . 238

CHAPTER VIII.—CORRELATIONS OF COMMUNISTIC INSTINCTS WITH THE FUNDAMENTAL LAWS OF DIFFERENTIATION AND INTEGRATION IN MORPHOLOGY AND DEVELOPMENT.

Integration in Morphology and Development, . . 242
Goethe's Development of the Law of Socialistic Unity, . 243
Zoonitic Constitution of Vermes, ... 244
Bilateral Composition of Organisms, . . . 245

Page
Special Forms of Socialistic Organisms,—
Amœba, Sponges, Hydras, ... 246
Polyzoa, ... 247
Siphonophora, ... 249
Vermes, ... 251
Many-eyed Socialistic Organisms, . . . 255
Communistic Reproduction, ... 257

CHAPTER IX.—THE PHYSIOLOGY OF THE CORPOREAL FEELINGS AND DESIRES.

§ 1. *The Modifications of the Cœnæsthesis.*

Primary form of Love of Pleasurable Existence, . . 261
Nature of Anæsthesia, ... 262
Feelings of Diseased States—Paræsthesia, . . 263
Nature of the *Vis Medicatrix Naturæ*, . . . 264
Morbid Blood as a Cause of Morbid Feelings, . . 265
Nature of Hyperæsthesia, ... 267
Euphoria and Insane Joyousness, ... 268

§ 2. *Morbid Modifications of the Appetites and Desires.*

Modifications in Hysteria and Hypochondriasis, . . 270
Anæsthesia of the Egotistic Feelings—Indifference to Life, 271

CHAPTER X.—PHYSIOLOGY OF THE APPETITES.

Appetite for Light, or Light-Hunger, . . . 274
Ethnic Influence of Light, ... 276
Appetite for Warmth and Coolness, . . . 277
Regulative Centres for Temperature, . . . 279
Air-Appetite, ... 280
Water-Appetite, or Thirst, ... 281
Food-Appetite, or Hunger, ... 283
Morbid Food-Appetite—Bulimia, ... 284
Special Alimentary Appetites, ... 285
Climatic Alimentary Appetites, ... 285
Habitual and Paræsthetic Appetites, . . . 286
Appetite for Muscular Activity, ... 287
Appetite for Open-air Life, ... 288

Page
Habitual Desires for Muscular Activity, . . . 289
Instinct for Muscular Activity in Boys, . . . 290
Appetite for Variety in Food, ... 291
For Variety in Mental and Sexual Stimuli, . . 292
The Sensual Appetites, ... 293

CHAPTER XI.—PHYSIOLOGY OF CORPOREAL LOATHINGS AND AVERSIONS.

Respiratory Loathings, ... 295
Disgust, ... 296
Idiosyncrasies, ... 298
Abhorrence of Restraint, ... 298
Aversion to Activity—Nature of Sleep, . . . 299
Languor and Drowsiness, ... 302
Loathing from Satiety—Sexual Loathing, . . 303
Loathing of Life—Suicidal Melancholia, . . . 304

CHAPTER XII.—ON THE RELATIONS OF THE VITAL POWERS TO MENTAL CHARACTER AND MANIFESTATIONS.

§ 1. *On the Temperaments.*

Early Doctrines of the Greek Philosophers, . . 306
Ethnic Temperaments of East and West, . . 308
Origin of Sanguine and Bilious Temperaments—the Arthritic, ... 310
Vascular-Arthritic, Rheumatic, Lymphatic, Nervous, . 311

§ 2. *The Differences in the Constitution of the Sexes.*

The Constitution of Woman as compared with Man, . 312
Differences in the Sexes as to the Blood and Blood-vessels, 314
Differences in the Sexes as to the Nervous System, . 316
Peculiarities as to General Paralysis of the Insane, . 317

§ 3. *Individual Differences of Character; Differences in the Development of the Faculties.*

As the Result of high Cultivation of the Faculties, . 320
Differences in the Quality of the Brain, . . . 322

Page
Differences as to Sensibility and Temper, . . 324
Pathological Relations of Melancholia and Wit, . . 325
Pathological Influence of Attention, . . . 326

PART VI.—PRINCIPLES OF MENTAL ORGANOLOGY.

CHAPTER I.—GENERAL DOCTRINES OF THE FUNCTIONS, MORPHOLOGY, AND STRUCTURE OF THE NERVOUS SYSTEM.

§ 1. *General Functions of the Nervous System.*

Differences between the *Vis Nervosa* and the Vital Forces, 331
Illustration of the Co-ordinating Action of the *Vis Nervosa* in Muscles, ... 333
And in the Visceral Systems, ... 336
Teleiotic Elements of a Nervous System, . . . 337

§ 2. *The General Homologies and Anatomy of the Nervous System.*

Doctrine of Homologies examined, . . . 338
Illustrations of Teleiotic Homologies, . . . 340

CHAPTER II.—THE DYNAMIC AND STRUCTURAL ELEMENTS OF THE NERVOUS SYSTEM.

§ 1. *Nerve and Nerve-cell, as Elements of the Nervous System.*

The Development and Structure of Nerve-fibril, . . 344
Function of Nerve-fibrils—Ganglionic Nerves, . . 346
Nerve-plexuses and Nerve-cells, ... 347
Nerve-cells of the Sympathetic and Intervertebral Systems, 350
Nerve-cells of the Spinal Cord and *Medulla Oblongata*, . 352
Nerve-cells of the Cerebellum, ... 353
Nerve-cells of the Cerebral Ganglia, . . . 355
Pigment-deposit in Nerve-cells, ... 356

Page

§ 2. *Elementary Anatomy and General Functions of the Ganglionic Centres.*

Combination and Arrangement of the Cells in the Grey Matter, ... 358
Ganglia as Plexuses and Nuclei, ... 360
Evolution of Ganglia, ... 361
Laws of Action of Ganglionic Cells, . . . 363

CHAPTER III.—EVOLUTION IN DEVELOPMENT AND FUNCTION OF THE NERVOUS SYSTEM.

§ 1. *The Teleiotic or Primordial System.*

Primordial Type of the Nervous System, . . . 369
Relations of Cutaneous Eyes and Ears to the Sympathetic, 370
Relations of Viscera to the Sympathetic, . . . 371
Evolution of the Sympathetic, ... 373

§ 2. *The Cerebro-Spinal System.*

Composite Homologues of the Cerebro-Spinal Centres, . 374
Modes of Integration of Serial Ganglia, . . . 375
Bilateral Integration, ... 376
Polar Integration—Law of Evolution of the Head, . 378
Evolution of the Posterior Extremity in Invertebrates, . 380
Pathological Importance of the Doctrine, . . . 383

CHAPTER IV.—ON THE FUNCTIONS OF THE SYMPATHETIC AND INTERVERTEBRAL SYSTEMS.

§ 1. *The Sympathetic System.*

The Secondary Ganglia of the Sympathetic, . . 385
Homologies of the Sympathetic with the Vertebral Axis, 386

§ 2. *The Intervertebral System.*

General Morphology, ... 389
Co-ordinating Relations of the System, . . . 391
Laws of Nutrient Activity of the Intervertebral System, . 393
Experiments of Bernard, Brown-Sèquard, Schiff, Magendie, &c., 393
Peripheral Origin of Centric Disease, . . . 395
Explanation of Symmetrical Diseases, . . . 396

PART IV.

PRINCIPLES OF A SCIENTIFIC PSYCHOLOGY.

Having thus determined the causal laws of Mind, considered as an ordering force, both in the abstract and as the efficient agents in organisation and development, we have now to apply the results of our inquiry to the discovery of the correlations of Life and Thought. In other words, we have to determine by what laws the encephalon is evolved into the organ of consciousness; by what laws mental operations are developed in the living tissue; and what are the fundamental correlations of Life and Thought. We have to set forth the primary laws of Vital Affinity, as they are manifested in our organisation; how it is that through these we are in possession of appropriate tissues or organs; how we attain to primary Intuitions, Beliefs and Desires; how we acquire and use our Mental Faculties, as conscient and rational beings, in and through organisation; and finally, how the unity of Life and Thought is manifested in the highest development of the Human Mind.

CHAPTER I.

ON THE SUBSTRATUM OF CONSCIENT MIND, AND ON THE METHOD OF DETERMINING ITS LAWS IN RELATION TO CONSCIOUSNESS.

Inasmuch as we have to deal with phenomena in all our mental processes, and since phenomena can only be manifested in what is termed Substance or Matter (202, 206), our first object of inquiry must be into the constitution of that living tissue in and through which Mind is manifested as unity.

313. We have seen, that, in all speculations as to the physical forces, the idea of a substratum, or substance in which they operate, is a necessary element (204, 205). There may be, in fact, nothing but force; and what we call Matter may only be, as some think, an infinite number of centres of force. Yet, granting this to be the true explanation of the nature of what we call Substance, it can make no difference in our method of inquiry, for these centres of forces do not alter the actual relations to us of what we call Substance. A precisely similar question is involved in the relations of the vital forces and of consciousness, to the substratum in which Mind is manifested as an ordering force, when Conscious Existence arises. But since consciousness is considered by many as a first or final cause, and not a result of the same series of causes by which life arises, the notion formed was, that the substratum of consciousness differed in its nature and

laws from the substratum of the vital forces. How that substratum could be described, became necessarily an inexplicable puzzle; but the most common solution is, that it is an immaterial substance, or the Mind itself. Considered abstractedly, this proposition is a statement of a fundamental truth; it corresponds to that fundamental idea of creation we have already developed, which constitutes Mind, as an ordering force, the sole source of all the physical and vital forces. But inasmuch as Mind, in the proposition, is identified with individual Consciousness, or the "*Ego*," according to the Cartesian notion, the proposition considered in the concrete is false, for it enunciates what is contrary to all experience; so that, although founded upon a fundamental intuitive truth, the intuition was never evolved into derivative truths, but only into indistinct, confused conceptions. The source of error is precisely the same as that of the sun's motion round the earth, in which the intuition of force, as motion, is evolved into the truth of experience that there is motion; but when it was affirmed that it was the sun that moved, the fundamental truth failed at the outset to be evolved into derivative truths.

314. Hence all the phrases of the metaphysicians, as well as of common language, include the fundamental intuition of a substratum or medium, by which we think, and feel, and act. But the aberration from experience at the outset, by which consciousness is separated from organisation, and the causes of mental changes from the causes of vital changes, has necessarily rendered all these terms obscure, ambiguous, and contradictory, and involved all philosophy in error *ab initio*.*

315. In all metaphysical discussions, therefore, the idea of a *substratum* of conscious states is ever present; and

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* Compare Part III. chaps. iii. and iv.

do what we will, we must call it substance of some kind — immaterial, spiritual, material. Nevertheless, although we term it Substance and Material, yet, if inorganic matter be but an assemblage of forces, *a fortiori* we must predicate the same of the matter of the brain, so highly organised as it is, and so conclusively the seat of Mind. But even as an integration of forces we still must speak of it as a substance, in so far as its forces are in relation to our states of consciousness; for Substance, or Matter, is fundamentally nothing more than that which is the seat of motion to ends, of which Mind is the source and cause (205). Hence, as a scientific question, the inquiry whether Mind is material or immaterial, is valueless.

316. With this understanding of the term, let us now examine the vital substratum, or living matter—the medium of those mental forces and vital affinities (297, *sqq.*) in or by which our various states of consciousness arise, and which is constructed for the play of those affinities by the operation of the vital forces themselves, as derivatives of the universal Mind to that end (179). This examination will enable us not only to appreciate more clearly the true character of that substratum, but to adopt a method whereby we may make the laws of the vital affinities, in their relation to conscious states, a subject of scientific research.

The necessary connection between states of consciousness and vital changes, has always attracted the attention of metaphysicians and physiologists, and the phrase "material ideas" has been used to designate the latter. This is a very ambiguous phrase, for strictly it means ideas of or belonging to matter or substance; whereas *ideas*, in the usual sense of the word, can only belong to Mind. "A psychological materialist," Unzer remarks, "considers these material ideas as the ideas of the mind itself. But since it must be firmly maintained, that the thinking faculty is an immaterial substance, it cannot certainly be granted that these material changes in the brain are really the ideas themselves; but since the two are inseparably connected with each other, and the mind never acts, nor can act, in animals, without these [cerebral] movements, it is fully established that every act of thought presupposes and causes a conception in the mind; that the same or a similar conception excites the same or a similar material idea; and that the same or a similar material idea excites the same or a similar conception in the mind; that when there are no conceptions excited in the mind, there are no material ideas, although probably similar movements may take place in the brain; that when no material ideas take place in the brain, no conceptions come into real existence in the mind," &c.*

317. Unzer particularly guarded his readers against the materialistic hypothesis adopted by various contemporary writers, to the effect that these material ideas corresponded to hieroglyphical figures of the objects of the conceptions, or to impressions stamped on the medullary substance of the brain. Haller propounded such a theory, for he remarks, "Eas mutationes in sensorio conservatas, *ideas* multi, nos vestigia rerum vocabimus, quæ non in mente sed in ipso corpore, et in medulla quidem cerebri ineffabili modo incredibiliter *minutis notis* et copia infinita inscriptæ sunt." Bonnet built up a metaphysical theory upon this doctrine. Hooke theorised on the formation of these material ideas, and estimated how many could be made in a day.

318. It is certain that some theory of the relations of consciousness to organisation is necessary even to obser-

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* *Erste Gründe Einer Physiologie*, &c., p. 42 (Leipsic, 1771); and my translation for the Sydenham Society, p. 25.

vation and research; but it must be established on a much wider basis than either metaphysics or physiology has yet offered—namely, in the great correlations of conscient mind, with life and organisation on the one hand, and the Creative Mind on the other. Such a theory (which I now propose to develop) should therefore offer, as its primary recommendation, the possibility of bringing within the sphere of scientific research, not the correlations of Life and Thought alone, but the correlations of Life and Thought with the physical and chemical laws and forces of Matter. This conclusion follows from a consideration of the principles already established; for if we apply them deductively to those phenomena of which the sciences of human nature treat, we see that the great generalisation under which we subsume all other great laws of the universe, is applicable to them as well as to the phenomena of nature at large. In the natural sciences we examine the operation of the physical forces of nature, and formularise their laws; in the sciences of human nature, the inevitable law of design takes the place of the inevitable forces which compel towards an unchangeable order. But just as the varied phenomena of nature are only apparent deviations from the fixed unchangeable laws of nature, and are operated by their forces (98), so the varied phenomena of human life and human nature are only apparent deviations from the fixed unchangeable law of design, and are operated by its force, Mind (147). Consequently, the object of all mental science itself may be defined to be a knowledge of these deviations from this law, as manifested in the phenomena of Life and Thought formularised in laws.

319. According to these premises, there are four separate steps to be taken to arrive at this end. *Firstly*, It is necessary to discover the fundamental laws of Existence,

and prove the accuracy of the discovery by the double method of deduction and induction. This we have already attempted. *Secondly*, It is necessary, by a similar process, to ascertain the fundamental laws of Thought considered as the result of the exercise of pure reason, both *per se*, or abstractedly, and in correlation with the laws of Existence. This we have also attempted. *Thirdly*, It is necessary to fix in like manner the fundamental laws of Consciousness, in correlation, on the one hand, with the fundamental laws of Existence; on the other, with the fundamental laws of Thought. This we are about to attempt. Next, having laid down these general laws, we shall take the *fourth* step in the procedure, and show how they are applicable to MENTAL PHYSIOLOGY, or a scientific exposition of the inseparable relations of mental and vital forces, as manifested in the mental life of organisms.

320. We have seen already, that amongst the most important obstacles to the advancement of Mental Science is that *ignava ratio* which finds, in the relations of consciousness to organisation, a matter wholly unscrutable.* If, however, we admit the foregoing premises, we can conceive a method which shall enable us to investigate the correlations of the physical and vital forces on the one hand, and of these again with Mind, so as to constitute the inquiry a fundamental department of natural science.

321. This new method must be founded on a fundamental proposition, considered as a firmly established truth—namely, That Mind, as the first cause, is not only inseparably associated with the primary forces of matter, but that it acts in and by those forces alone. The results of those forces in action are its exponents; their

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* Part I. chap. ii. p. 48.

phenomena are its signs or language, the expression of its thoughts (146). This being true as to the general laws of nature, is true also as to those particular deviations from those laws which, operated by the forces themselves, constitute the phenomena of life and organisation; and consequently the phenomena of life and organisation are true and manifest exponents of the laws of thought. And this further conclusion is inevitable, that the connection between the physical forces on the one hand, and the laws of mind on the other, is not only not inscrutable, but that those laws can only be investigated in correlation with the laws of life. To attempt it otherwise, is to adopt a method exactly similar to a method of investigating the laws of the Creator without the creation, or the operation of the great forces of nature without an examination of the phenomena of nature.

322. To apply these views:—We have seen that the molecular forces of matter, known as attraction and repulsion, light, heat, electricity, galvanism, and chemical affinity, are correlative on the one hand with the primary forces of matter; on the other hand, with the vital forces of which the so-called "nerve-force" is the type.* It follows, therefore, that since we can reduce the laws of the physical forces to numerical expressions, we ought to be able to reduce the laws of their derivative forces—those of life and organisation—to numerical expressions (144). Now, this we are actually able to do in some degree as to those known as the laws of nutrition and development of organisms (247). We may, however, advance even a step further, and extend the method to the laws of life and organisation in correlation with the laws of thought. For since all the successional states of our consciousness correspond to successional vital states, and since these

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* Part III. chap. iii. vol. i.

occur according to the law of the vital forces, it is clear that the signs which express the successional states of the one may be made to express or correlate the successional states of the other.

323. It is very necessary, however, to bear in mind, in considering this question, that it is not changes in the mere matter of the brain in the concrete (as many are apt to think) which constitute the vital processes that are correlative with mental states; on the contrary, such changes taking place put a stop to the phenomena of thought, and often, indeed, of life. The changes we have to consider are dynamic, or teleorganic,* and are operated by those same vital forces by which the brain itself is built up, so that it shall, as a whole, be in express adaptation to the end that these successional states of consciousness should take place. In other words, the incessant vital changes which correlate thought do not differ in their nature from those which correlate growth, nutrition, and development.

324. It is further to be carefully noted, that, as the vital forces correlate the physical forces, their laws of action will correlate the laws of action of the physical forces. Now if, in examining into these, the physicist has to distinguish between them and that substratum (whether atomic or not) in which they are hypothetically con-

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* This very significant and useful word was first used by Mr G. H. Lewes, who says, in explanation of it, "Matter is divided into Inorganic and Organic. In 1853 I proposed a modification of the division into—1. Anorganic; 2. Merorganic; and 3. Teleorganic: the first including those substances usually styled inorganic; the second including those in an intermediate state, either wanting some addition to become living, or having lost some elements, and passed from the vital state into that of product; the third including only the truly vital substances."—*Biographical History of Philosophy*, 2d edit. note, p. 636.

ceived to act, it is much more imperative on the physiologist and metaphysician to distinguish the forces with which he has to deal, from the substratum in which they also must hypothetically be conceived to act. These forces are put into action by what are really physical forces; for all the impressions made by mere matter or organisms are in fact vital changes induced by the physical forces of matter (206); while all the impressions derived from living things, whether visual or auditorial, are equally made through the medium of those physical forces, and not otherwise. Every impression on the senses can be thus resolved finally into an impression of contact or touch; so that Touch is the fundamental sense, and all the organs of the senses are but very delicate instruments of touch. Such is the general law deduced from observation and experiment; such is the only law at which we can arrive *à priori*;* for since the vital forces are correlative with the physical, they can only be modified by those which correlate them.

325. Fifteen years ago I stated formally this doctrine of substrata of psychal† phenomena, in explanation of the automatic and unconscious action of the cerebral hemispheres on the muscular system, in adaptation to ends and in thought. I thus remarked: "*The Substrata of Psychical Phenomena.*—The question necessarily arises, how it is that, when an impression is thus diffused through the cerebro-spinal axis, certain groups of muscles,

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* Compare especially on this point, Sir William Hamilton, *Lectures on Metaphysics*, vol. ii. p. 152, *sqq.*; and Mr H. Spencer, *Principles of Psychology*, part iii. chap. viii.; also Aristotle, *De Animâ*.

† I prefer to use the word "psychal" in place of "psychical," as being, I think, both more euphonious and correct.

the contractions of which constitute instinctive, emotional, consensual, and volitional actions, are excited into energy? The answer must be sought in a knowledge of the histological composition of the cerebro-spinal axis, and of the nature of the bio-molecular changes induced therein, and on the periphery [of the nervous system], by the forces of matter. . . . The doctrine of a molecular organisation within organised structures, such as that it shall correspond and be appropriate to given stimuli received by appropriate organs, necessarily constitutes the basis of all inquiries into the laws of action in those structures. And there can be no doubt, such is the magnificent uniformity in the universal diversity of creation, that the laws of action of the agent and re-agent in vital phenomena might be shown to be as definite as those operating in chemical phenomena, could we but effect a sufficiently minute analysis and induction."*

326. Those substrata, the telcorganic changes of which hypothetically correspond to notional states of consciousness, I termed *ideagenic* substrata; those, the telcorganic changes of which correspond hypothetically to motor phenomena, I termed *kinetic* substrata; and I pointed out certain general laws as to their origin, development, latency, and transmission to offspring, in explanation of a great variety of psychal phenomena of the instinctive character.

327. Five years ago I further developed this doctrine in its applications to the intellectual powers, and demonstrated the analogy between the instinctive processes and acts of lower animals, and the arts and reason of man.

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* Appendix to my paper "On the Reflex Function of the Brain," read at the meeting of the British Association held at York, September 1844, and published in the *Brit. and For. Med. Review*, January 1845.

As to the doctrine of psychal substrata I observed, "By this I do not mean to imply a certain material arrangement of cells or their elements only, but such an arrangement that a fixed order of successional changes, or plan of action, may be impressed upon them. Thus each primordial or embryonic cell has its psychal substrata, in virtue of which there is a continuous series of successional changes in a fixed, predetermined order, and according to a fixed plan. So also in these cell-masses (or vesicular nervine) appropriate to special ideas there are psychal substrata, in virtue of which there is a constant construction of new cells, corresponding to those new states of the consciousness comprised under the general term *development of ideas*, the ideas being developed, and the new cells constructed, according to a fixed and predetermined law of development. The substrata have *potential* properties—that is to say, they contain the elements of further and indefinite series of future changes, as well as properties in actual use in relation to the external world."* In the same paper I showed how the perfect results of the law of design, manifested in the development of form, correlated our intuitions of the Beautiful; and that it is these intuitions which, when fully developed by converse with true morphological developments, are embodied in works of high art. These substrata correspond to the *Species impressæ* of the metaphysicians, and the correlative states of consciousness to the *Species expressæ*.†

328. Now, as all the sequences and co-existences which go on in organisms, from the first moment of contact of the sperm-cell and germ-cell, are in the same definite rela-

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* *Brit. and For. Med. Review*, July 1855, p. 189; and *Jour. of Psychol. Med.*, Oct. 1855, p. 540.

† Compare Sir W. Hamilton. *Reid's Works*, p. 267.

tions to each other as the changes termed "affinities" in chemistry (298), it is obvious that in our investigations of the laws of conscious states we have a like class of phenomena to deal with, and that we have to detect and formularise the vital affinities in or by which necessary states of consciousness, and all their derivatives, arise. Now, the results of all those teleorganic changes which arise and go on in accordance with the laws of the vital affinities are presented immediately to our consciousness, without the intervention of any other machinery than the nervous tissue, which is constructed to that end. Hence it follows that we have in our varying states of consciousness direct and immediate cognitions of the operation of the physical, vital, and mental forces within us; or, in other words, that in our nervous system, rightly used and aided, we have an instrument of research into the nature and forces of matter unequalled in its powers and capabilities by any other instruments or means whatever (p. 6). And it is not too much to hope, that by means of that instrument, aided by improved mechanical aids and methods of research, the intimate nature of all matter, so far as it is possible to know it, may be finally deduced from these direct cognitions of our consciousness, of which our intuitions, or intuitive ideas, are the first elements.

329. If these premises be granted, the metaphysician can occupy at once a vast field of experimental observation and research, and investigate the forces of mind acting through living matter in the same way as the chemist investigates the chemical forces of matter acting in unorganised matter. But he has this advantage over the chemist, that while he is able to analyse the phenomena of his own consciousness, as his own internal experience of the results of the molecular changes which the ever-changing organised matter that constitutes his

body undergoes, he can look abroad into universal nature and analyse the great Thoughts which are at work therein, through their results, as manifested in Creation (180). In the ideas of that all-pervading Intelligence he may clearly discover the truths that are but dimly reflected in the mirror of his own consciousness, and presented too often in forms distorted by disorder or disease. In this way the physiological metaphysician will be enabled to determine the laws of Human Nature by the same method which has been followed in determining the laws of Life; and to build up a mental science, which, founded upon the broad basis of a Scientific Ideology (180) and a Philosophical Biology, will take its place amongst the other applied sciences as the end and completion of them all (vol. i. p. 32).

CHAPTER II.

FUNDAMENTAL CORRELATIONS OF LIFE AND CONSCIOUSNESS.

SECT. I.—*The Evolution of the "Concrete Ego."*

330. THE correlations of biotic or teleiotic ideas with fundamental laws of thought having been already set forth in part in our Mental Dynamics of Biology,* we need only place the general principles then developed in more definite relation to fundamental conscious states. There are three classes of them which can be discriminated in every act of consciousness taken as unity. They may be best described as intuitional, and are—1. The intuition of Existence, or State of Knowing; 2. The intuition of Feeling, or State of Pleasure, Pain, Desire, Aversion, technically the Feelings; 3. The intuition of Acting or Energising to an End—the Will, or Volition. These three states are represented in language by verbs or words which signify mental or bodily change, as *to be, to do, to feel.* By Sir William Hamilton (following Kant) they are made the basis of a psychological arrangement, comprising primarily three classes of Faculties—namely, the Cognitive, or faculties of Knowledge; the Orectic or Appetitive, the faculties of Desire and Feeling; and the Conative, or faculties of Action.

331. Although we can discriminate these states of consciousness one from another, by correlating the pre-

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* Part III. chapters xi.–xiii.

dominant idea or law of each, there is a universal idea, a something common to them all (91). If, then, we can determine the general law of relation of this element to the organisation, we detect the general law of relation to the organisation of all other and special states of the consciousness. That universal element is their unity as one act of consciousness (17). Now, this law of unity is the primary teleiotic law of life and organisation. Without it there can be no existence. We may be in doubt as to whether an organism is conscious or not, or differ in opinion as to whether man in certain conditions becomes, or is unconscious; but whatever may be our conclusion, it is certain that if a conscious organism acts as one, and not as many, it also feels and thinks as one, and not as many. It may not think or know, still it will feel and act as one; it may neither feel nor think (as may be the case with a plant or animalcule), still its vital energies co-operate to one fundamental end: It is an organisation.

332. It follows, therefore, as a first truth of consciousness, that man's fundamental cognition, that he is One, correlates the fundamental teleiotic idea of creation and of organisation (280–281). The cognition or knowledge of self as One, is coincident with the ultimate *result* of the operation, according to a law of design, of all those derivative or vital forces which build up his body into one. It is the great truth of his nature as a conscious animal, and he is constructed in adaptation to this fundamental end. It is a necessary truth, because unity is a fundamental and a necessary law of both his mental and corporeal existence. Whenever, therefore, he has a consciousness that he is two individuals, he is suffering from disorder of some portion of that tissue, the encephalon, which ministers to his consciousness in unity.

333. What is predicable of the fundamental intuition of man is equally true of all its *contenta*, so that it is a necessary deduction, that all the minor states of consciousness which make up the intuition of the *Ego* or I, are, equally with it, the result of those derivative or vital forces which, in their respective spheres, contribute to the unity of the organisation. Consequently, all our intuitive beliefs and ideas correspond to teleorganic changes in the vital tissues, and through these to derivative teleiotic ideas. It follows, therefore, that the intuitive feeling of Existence includes all other intuitive ideas; and since this primary intuition expresses the result of the biotic processes by which organic unity is established, it equally follows that other and derivative ideas are equally dependent upon the results of these processes.

SECT. II.—*Corporeal Consciousness, and the Range of its Development.*

334. The common sense and experience of mankind have marked out two fundamental modes of conscious existence in which pleasure or pain is a predominant element, and which are named respectively Corporeal and Mental. In the *corporeal* states of consciousness of this class, the causes of the pleasure or pain are referred to states of the body, or of some portion of it, which is said to be the seat of the feeling. In the *mental* class, they are either referred to the encephalon, or, more commonly, the cause of all the changes in the encephalon, upon which they depend, is instinctively apprehended as Mind, Soul, or the like (313); so that the changes in the modes of operation of that cause are termed states of Mind, of the Soul, or of Consciousness. These two fundamental classes of states of consciousness are described as

Feeling, and their special modes, Feelings. There are therefore corporeal feelings, the causes of which are, for the most part, matter of direct observation, or are objective phenomena; and mental feelings, or the feelings proper, which are subjective phenomena, the causes of which, being encephalic and vital, are intuitively perceived, and cannot become matter of direct observation.

335. The distinction thus made implies in reality a difference as to the cerebro-spinal centres involved. In corporeal feeling simply, the change is referred to a point at which the afferent or sensory nerve begins; in mental feeling, it is associated wholly with thoughts. In the one case, the thoughts, if involved, are developed to determine the cause, and its mode of removal; in the other, the cause is found in the thoughts or volitions themselves.

336. Feeling, simply, is sometimes termed Sensation (19–21); thus some speak of the sensation of pain. Or the word designates a particular state of feeling; thus we speak of the sensation of heat, of cold, of hardness. The term is of the vaguest; for, strictly, the corporeal feelings, or sensations, are states of consciousness, of which the general law is, that they are referred to something external to the organism as the cause of the state. Thus we say vinegar is acid, or causes the sensation of sourness; strychnia causes a bitter taste, &c. The class is altogether different from states of consciousness arising from internal *stimuli* acting upon appropriate nerve-centres, derived either from the blood, from the co-ordinated action of viscera, or from other nerve-centres, and which have the name of Feelings, as well as Sensations, given to them. Of this kind are Hunger and Thirst, "Lowness of Spirits," and the like. The Sensations, in general, are very complex, especially in the higher animals. The greater differentiation of the recipient organs introduces

an infinite variety of impressions; the changes induced by these have to be combined and rendered homogeneous, so as to be presented as one series of changes to the consciousness. To provide for this integration, appropriate nerve-centres are required, and the changes in these require to be co-ordinated and combined. Hence we have manifestly connoted by the term a variety of general states of consciousness as complex as perceptions (63).

SECT. III.—*Is Feeling a Cause of Adapted Movements?*

337. Physiologists were long in deciding the question as to the connection between *Sensation*, considered as a consciousness of the external impressions which precede adapted movements in man, and the movements themselves, since they are so intimately associated, when both are normally excited, as to be inseparable in cognition. As an act of adaptive Energy is felt to accompany the sensation or consciousness of the impression, the movements were designated spontaneous or volitional movements. This is still the case with some Continental physiologists. But then very often the man tried, and sometimes in vain, to control the movements by an act of will; hence it was necessary to distinguish them as involuntary movements—that is, contrary to, or independent of, the will. But then, if contrary to and independent of the will, what are they caused by? This question, Unzer first, and then Prochaska, answered by developing the doctrines of reflex action. These physiologists taught, that the impressions which reached the cerebro-spinal centres (designated the *Sensorium Commune*) from the periphery were transferred to the motor nerves; and thus being reflected or turned back from the centre, were sent along them to the muscular periphery. And as consciousness was proved by ex-

perimental research to be dependent upon the existence and integrity of the encephalon, or certain portions of it; and as it was found that in many vertebrates, and in all invertebrates, these adapted acts still took place, although the head, and therewith the encephalon—the seat of consciousness—was wholly removed, it was concluded they were wholly independent of consciousness as *the cause.*

338. Now, few deny this doctrine as to the spinal cord, but many still hold that Sensation is the cause of those automatic movements which are excited by impressions derived through the cerebral nerves. Dr Alison was one of the most able expounders of this view; Dr Carpenter is the most modern; he has also given it a more definite form, by designating the class of movements "*Sensori-motor,*" in contradistinction to the "*excito-motor*" of Dr Hall. He also allocates the causal sensations in what he terms the *Sensory ganglia*—namely, the masses of encephalic gray matter in which the nerves of special sensation (the cerebral nerves) are supposed to terminate. This is simply a revival of the old doctrine of a *Sensorium Commune* which Prochaska very distinctly formularised.* Obviously, such a doctrine can have no scientific basis until the nature and laws of consciousness are better determined; now it is not even yet determined what organisms are endowed with feeling.

339. The researches of physiologists, as to the limits of consciousness in the organic world, having been hitherto restricted to animal organisms—and as to these, for the most part to organisms endowed with a nervous system—the general law of adaptive action has been overlooked, and that which is a general property of all living tissue (154, 157) has been considered as not only a special pro-

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* *On the Functions of the Nervous System.* Chap. iv. "The Functions of the Sensorium Commune," my translation, p. 429.

perty, but the exclusive property, of a nervous system. It is probably true that the nervous system is the sole and appropriate tissue of all conscient changes, and that without it there can be no such mental states in animals as we designate by the phrase "states of consciousness." But it is much more certainly true, being a fact of universal experience, that many, if not most of the changes which go on in the nervous system of man, are as wholly unconnected with, and independent of, consciousness causally, as any other vital changes whatever. They belong essentially to the great group of vegetative processes (45). And the encephalon be admitted to be the exclusive seat of consciousness in man and vertebrates, and if it be further admitted that every living cell or living fragment of an organism, when separated from the whole, cannot have feeling, then we may affirm that the unconscious character of reflex acts, and their entire independence of states of consciousness, has been abundantly proved, both by experimental vivisections and pathological observations.

340. It is now a settled principle, therefore, that in Feeling animals it is not to the feeling or sensation of pleasure or pain that the adapted movements of alimentation, conservation, and the like, are due, but to the teleorganic processes in the nervous centres by which force is developed therein, and transferred for the express purpose, as a part of the great plan of the organism ; due, in fact, to the same nervous changes to which the change in the consciousness itself is due. This principle, applied to the vegetative processes of the brain, we shall find to be of the utmost importance to the elucidation of the relations of Thought and Will to the encephalon, and to the comprehension of the morbid changes they and it undergo in all forms of insanity. Upon this extension and application of the principle to purely mental phenomena, which I

claim as peculiarly my own, must be based all the doctrines of corporeal concurrence in changes of the consciousness, and all the correlations of the laws of Life and Thought.

341. Although this question has been so much discussed of late years, physiologists have not yet attained to a definite conception of the relation which feeling, or simple sensation, bears to adapted or instinctive movements. It will be useful, therefore, to examine the method pursued for determining it. It is very obvious that the sure method of induction has not been generally followed out. Thus, it is usually affirmed that plants do not feel, and that animals do; and that this is the essential distinction between them. Now, this general proposition, so universally accepted, is very doubtful, and is founded on wholly insufficient data. In the *first* place, it is assumed that all animals are conscious; *secondly*, that those which are conscious are all endowed with the same kind of consciousness; *thirdly*, that plants have no consciousness. The method by which these conclusions are reached is not complex. We find, by experience, that there are certain functions going on in our own selves through structures, of the existence of which we have no consciousness whatever; these we term the organs of vegetative life, because we see an analogy between these functions and the processes of vegetative life. We find, on the other hand, that we have organs which are in immediate relation to our various states of consciousness, and we term them, therefore, the organs of animal life; and organisms which have analogous or similar organs, we designate Animals. Hence, the ordinary distinction between plants and animals is based on metaphysical assumptions founded on the phenomena of our own consciousness.

342. That some lower animals feel and think, is inferentially as certain to the individual as that all other men feel and think; but as a fact of observation, each man can only know certainly that *he* feels and thinks. So soon as he passes from the certainty which his own consciousness supplies, to deductions as to the states of consciousness of other organisms, drawn from observations of their actions, he enters into a sphere of inquiry in which there are abundant sources of error. And, in fact, a fundamental error greets him at the very outset. For inasmuch as man finds that all his adapted acts of external relation are accompanied by their correlative states of consciousness, while all his processes of internal relation go on without any consciousness on his part, he not only draws the distinction between the two kinds of processes, and designates the one *animal* and the other *vegetable*, but he also draws a distinction as to the *cause* of the difference. In this way he concludes that Consciousness is the cause of the one series of vital phenomena, and something else, variously named Vital Principle, *Anima Mundi*, *Archæus*, &c., is the cause of the other (43).

343. Now, there is a large number of purely vital movements of external relation as well as of internal, which manifestly show that a principle of adaptation to external things is in operation. In plants, that principle is identified by many with Life; in lower animals, with Instinct. But while, as to the former, it is not inferred that they indicate conscience or feeling in the organism, as to the latter it is confessed that they do,—and this on the ground that such movements in man and the higher vertebrates are associated with feeling. And since an act of energy accompanies these movements when pleasure or pain is felt, so that a desirable end is aimed at, it is concluded that the feeling is the cause of the adapted movements.

But it is clear that this teleological theory ought to be equally applicable to the growth and movements of plants. Some of these, such as the "sensitive" plant, display motions of their parts strikingly similar to those of the lowest animal organisms. If, then, feeling be the assumed cause of the movements in the latter, why is it not the admitted cause of them in the former? To answer that they are plants, is simply to beg the question.

344. But the theory of Plant-consciousness cannot, in fact, be either proved or disproved: yet whether it be granted or denied, the difficulties of the question are not thereby cleared up. It is quite certain that the simple embryo-cells of both plants and animals (zoospores and zoids) both move and act in adaptation to their external conditions, and that their organs are developed in relation to each other, so that they constitute a whole. But then, in various instances, as they are developed into what may be termed a higher phase, they lose their animal-like locomotive freedom, and become either plants or plant-like animals; so that if the embryo-cells have feeling, the full-grown organism is apparently unconscious. This is so wholly opposed to the order of events in the higher organisms, that if we admit these lower forms to be conscious, the conclusion is obvious, that their consciousness wholly differs from that of man.

345. But then another difficulty meets us in the consideration of these "sensational" movements or "sensori-motor" phenomena, which the hypothesis fails to explain. It is found that fragments of organisms or of living tissue display the same kind of adaptability as entire organisms. Thus the heart of a sturgeon will continue to beat after removal from the body, and while hanging up to dry; the intestinal canal of a *Holothuria* will writhe

about, and move forwards with a worm-like movement, after entire separation from the animal; the severed tail of a lizard will leap; the separated abdomen of a wasp will push out its appended sting; nay, the cilia attached to a microscopic fragment of membrane may be seen to move long after removal from the body, or even so long after its death that it is beginning to become putrid. Do these fragments move because capable of sensation, and from consciousness? If so, then we must certainly admit that every spermatozoon, and every blood corpuscule, and every free-moving epithetial cell, are endowed with consciousness, and that their movements are caused by feeling.

346. These movements must not be confounded (as they generally are) with those which are observed in various helminthoid animals after division into sections or segments. These are already made up of distinct segments, each of which (as Moquin-Tandon has shown) contains the elements of an entire organism (248), and which, he believes, is endowed with a separate consciousness.* These animals may, therefore, be considered composite or social organisms, and as possibly endowed with a composite or social consciousness. Just as we know that the units of a regiment or battalion are individually conscious, and yet move as one organismic mass in unity in virtue of that individuality, so we can conceive the units of a composite or social organism to have feeling individually, and yet move as an organismic whole. Nay, we may even extend the hypothesis to plants, and allow these a kind of composite consciousness too. There is no very valid argument to be alleged against the notion, while a good deal may be said in its favour. But this is the im-

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* *Monographie de la Famille des Hirudinées* (2eme edit. 1846), p. 195.

portant consideration in all these cases, that we are not in a position to decide the question either in one way or the other. All that is really in our power is as to the relations of consciousness to our own movements, and inferentially, to the movements of other mammals or vertebrates. From these, we can conclude positively, that sensation is not really the cause of numerous adapted acts in us.

347. Looking at the whole class of movements which in vertebrates are associated with or seemed to be caused by sensations, physiologists have all acknowledged that their object is the conservation of the individual, and that they are due to the operation of a conservative machinery combined into action by both external and internal *stimuli*. There are sentinel structures so arranged, in connection with this machinery, that all that is necessary to its appropriate action is, that agencies of an injurious character shall either come into contact with the sentinel structures, or threaten to do so. The actions by which the conservation and defence of the organism and its organs are thus secured, without consciousness, are in vertebrate animals termed reflex acts, and are attributed to a special function of the spinal cord, which operates according to what Prochaska termed the "lex Nostri conservatio."* To this class of motions belong all those by which the surface is protected from injury,—as removal of the entire body, or retraction of the limbs or part affected; use of the limbs to remove any injurious agent; winking or closure of the eyelids to protect the eyes. To this group also belong all those combined muscular acts which defend the internal organs from injurious impressions,—as sneezing, when anything irritates sufficiently the nostrils; coughing, in irritation of the larynx, trachea, and larger

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* *On the Functions of the Nervous System*, my translation, p. 430.

bronchi; vomiting, in irritation of the stomach; spasmodic peristaltic action, in irritation of the intestinal canal; expulsory efforts, in irritation of the rectum, bladder, uterus. A sentinel apparatus is placed at the outlet or inlet of these viscera, so as to duly regulate the conservative machinery: it may act either with or without consciousness; and if with consciousness, *against* the will.

348. Now, unquestionably, a feeling of pleasure or pain is very often associated in conscious animals with the action of this machinery, and hence the inference that the feeling is the cause. We have seen, however, that the true cause is the action of the vital forces, according to the derivative laws of the great law of design; and that the "lex Nostri conservatio" is the fundamental law of all organisms, down to the minutest and simplest zoospore or zoid, whether they be conscious or not (255). Consequently, the feeling of pleasure or pain belongs, as a causal idea, to the whole organism, when it is capable of consciousness. It is the correlative of that fundamental law of adaptation to ends which is the primary biotic law, or law of Life; it is, as such, in relation to other states of consciousness as a fundamental intuition; while the teleorganic changes associated with it are the true causes, *i.e.* the immediate antecedents to these changes in the muscular and other tissues which occur at the same time that feeling itself arises.

349. Hence we must conclude that that simplest form of conscious existence into which feeling enters is general. The feelings, therefore, termed "corporeal" pleasure and pain are fundamental states of the *Ego*—the One—and consequently enter into all other derivative states. As such they demand special examination.

CHAPTER III.

CORRELATIONS OF THE DESIRES AND FEELINGS WITH THE LAWS OF VITAL ACTION.

SECT. I.—*Pleasure and Pain—Titillation.*

350. THE feelings termed Pleasure, Pain, and Desire, are intimately combined with all our active states of consciousness. It may be reasonably doubted whether they qualify all our *cognitions*, but there can be little doubt that by far the larger proportion of these latter are not indifferent (57). We may start in our inquiry from the fundamental basis of our intuitions. Examining these, we find that each intuition, considered as a cause (279), possesses three æsthetic or sense elements, as follows :—1. That of Existence, which is feeling simply as to pleasure or pain. 2. That of Relation, which is a feeling of truth, fitness, beauty, &c. 3. That of Change, which is the feeling of the desire to energize with a view to an end, or of energizing, or motives, will. Before we can examine the order of succession of our thoughts, we must examine these three states of feeling in relation with the teleiotic ideas which correlate the intuitional ideas, so as to determine their *nexus* and relative importance.

351. *Pleasure.*—It is known by experience, that when all the functions of the organs of the body are so performed that the ends for which they are developed are attained—namely, the perfect co-existence and sequence

of phenomena according to their laws—the continued existence of the organism in time and space is secured. Now, if the organism be conscious—and if conscious, if it be also capable of feeling pleasure or pain—then the æsthetic state which correlates this completion of the biotic laws is Pleasure, and there is a feeling of healthy happy existence, and vital vigour.

352. This æsthetic sensation is not limited to the body but is the most general idea of all the mental class of feelings. In individual, social, and intellectual pursuits, the attainment of the end desired is knowingly sought as a Pleasure to come; the end being attained, a state of consciousness arises of a pleasurable character, termed Satisfaction, Happiness. And since all states of the consciousness whatever are coincident with vital changes, it follows that those states of consciousness involving the intellectual and moral faculties, termed Pain of mind or Happiness, are not only equally coincident with vital changes, but equally correlate teleiotic ideas—*i.e.*, intuitions (179). Man's highest happiness, as well as his highest duty, consists, therefore, in a fulfilment of the ends of his being; and the highest knowledge or wisdom to which he can attain is a knowledge of those ends as aimed at by Divine Providence in his creation.

353. *Pain* is the antithesis and correlative of pleasure. Corporeal pain is that modification of the corporeal feeling which takes place when the vital processes are *contra-natural*, or *not* according to the plan upon which they are instituted, so that the ends aimed at are thereby not attained. Pain is nevertheless an end aimed at in the law of design—is a contingent teleiotic idea (162).

354. The ends of the constructive plans manifested in an organism are threefold. It is intended:—1. That

each organ shall efficiently fulfil the duty assigned to it. 2. That each organ shall be restored to the efficient fulfilment of that duty, when circumstances have occurred so that its mechanism is deteriorated or injured. 3. That each organ shall co-operate with all the others in harmonious combination or unity, with a view to the attainment of these ends, both in reference to individual organs and to them all as a common unity. These being attained, Life is pleasant.

355. When an organ does not efficiently fulfil the duty assigned to it—as, for example, when the stomach does not carry on efficiently the work of digestion, or the intestinal canal fails to transmit its contents onwards, or the heart or urinary bladder becomes over-distended—the consciousness undergoes a change, and the state termed Uneasiness, a corporeal feeling of a painful kind, arises. It is antagonistic to that state which accompanies the proper performance of the functions of the organ, and is obscurely referred to the anatomical position of the organ (334).

356. This feeling of uneasiness may be more or less intense; but when it reaches a high grade of intensity—such as is felt when the texture of the organ has experienced injury of a mechanical character—or, in other words, when its structure is so altered mechanically as to interrupt the due performance of its functions, then that state of the consciousness arises, known as the feeling of corporeal pain, or pain simply.

357. It is necessary, however, that the nerves and the encephalon, or at least that portion of it which is the seat of consciousness, shall be able to fulfil their functions, when the organism is under those circumstances which give rise to pleasure or pain. If these be so modified that the appropriate teleorganic changes cannot or

do not take place, then there is no pleasure or pain. Profound sleep, and the states induced by narcotics and anæsthetics, thus modify the nerves and nerve-centres, and through them the consciousness. On the other hand, if the appropriate teleorganic changes in the nerves and nerve-centres do take place, but morbidly, although there has been no injury to any part of the body, and although the functions are all duly performed, the consciousness will still be modified, and pain and pleasure felt. And in this case the pain will be referred to any part, as a limb or a viscus, the nerve or nerve-centre of which is the seat of these morbid teleorganic changes.

358. *Titillation.*—A modification of corporeal pleasure and pain is experienced when light touches, or touches to highly sensitive parts of the surface, excite the consciousness. This is known as the feeling of *titillation*, or of being tickled, terms derived from the cause of the state of consciousness. The feeling is primarily one of pleasure; it is only when in excess that it passes into pain. In this form it is termed *irritation*, or, as applied to the skin, *itching*. The feeling is fundamental, and correlates the fundamental feeling of aberration from the law of design. This fundamental feeling enters into all intuitions of the ludicrous and grotesque, and corresponds, therefore, to a derivative teleiotic idea of the Imperfect (306). It is feeling excited by changes of a kind yet to be investigated teleologically, but which, when in excess, pass into painful states. We shall shortly see that it is the fundamental intuition of an entire department of æsthetics.

SECT. II.—*Desire in General.*

359. The feeling termed *Desire* includes, as its fundamental element, the intuitions of Time. Desires are of two classes, according to the ends aimed at in the conscient act of Energy which Desire accompanies—one end being the attainment of what will give pleasure, or be satisfactory or beneficial; the other, the avoidance of what will be injurious, unsatisfactory, or painful.

360. Desire always implies the two fundamental intuitions of Time, which are correlative with Succession and Change in phenomena—namely, the Present and the Not-present; which latter implies also two others, its derivatives—namely, the Past, and the To-come or Future. Now, in all necessary successions it is the Past which has determined that which the Present is; and the Present is that which determines in like manner the Future (218). But this is only under the guidance of causal ideas (149, 150). Hence it is a fundamental biotic idea, that the Present shall always aim at the Future. This is correlated by an intuition of the Future, and by a belief in it; and a desire for the Future correlates both.

361. Fundamentally, therefore, Desire correlates the teleiotic idea of necessary succession and co-existences of phenomena, as events occurring in Time and Space, to a pre-designed end; for without that necessary relation of events in time and space, no order can be (154). But necessary succession, as we have seen, implies incessant change—a constant Becoming (217). Desire-to-become correlates, therefore, that teleiotic idea; for it is that state of consciousness in which something not present is necessarily sought after, so as to be present in succession to the Existing. It correlates, consequently, the tele-organic changes of co-existence and succession, which

coincide with the Becoming in organisms. It is therefore, in its most general form, the Desire for continued existence, and next for happy and healthy existence.

362. Thus it happens that in all states of existence—no matter what they may be termed—the Becoming, or Future, is aimed at in desire. And hence, also, it is, that the fundamental law of all instincts, whether vegetable or animal, which have reference to the maintenance of the individual or the species in time and space, is to provide for the future. Hence, also, it happens, that man's highest desire, as a rational Being, is to be prescient of and provide for the future. The fundamental teleiotic idea runs like a thread through the entire series of phenomena of Life and Thought, culminating in the fundamental intuitions of Science and Religion.

SECT. III.—*Special Fundamental Desires—Instinctive Desires.*

363. Desires may be variously classed, but the simplest method is that which arranges them into the fundamental and derivative. Amongst the *fundamental* are all the desires to energize, so as to attain the correlative intuitions, and which appear specially as desires to live, to act, to design, to know, to be perfect, to change, to unite, to divide, to form, to multiply, to repeat, and the like, together with all the derivative intuitions. These are often intellectual desires. Amongst the *derivative* desires, we would class all those in which pleasure or pain is a predominant element, as the corporeal appetites, the passions, emotions. In these the teleiotic ideas which correlate the conscious states are powerfully effective as causal biotic ideas, and change the vital processes profoundly. The desires of relativity vary greatly in their character, ac-

cording to the relations of the organism to external things. They are often in the individual only appetites and aversions; in social organisms, or in those in which the sexes live in pairs, or otherwise socially, they give rise to a great variety of social desires, known as sympathies, antipathies, affection, hate, &c.

364. *Desires as to Good and Evil.*—That which causes us pleasure or prevents pain, whether of mind or body, we term Good, or the Desirable, and seek after it; that which causes us pain, or prevents pleasure, we term Evil, or the Undesirable, and seek to avoid it. These fundamental desires correlate, therefore, fundamental ideas as to the Absolute in the law of design, with their contingent or aberrant ideas. We have therefore the same question arising which we have already discussed when considering monstrosities or imperfections of Function and Form, and the doctrines we then stated apply equally to these desires. We need only repeat, that as the *Absolute* aimed at in the law of Design is absolute good by means of Order, or an inevitable and necessary series of events tending to Perfection (308), there cannot, strictly speaking, be disorder in creation. So it is with the fundamental intuitions of good and evil in relation with the correlative fundamental desires. Order and Good are manifestly synonymous terms, as are Evil and Disorder. Hence when our bodies are disordered, our state is evil or ill (illness), and we suffer pain, or perform the functions of existence imperfectly. But, since "order is Heaven's first law," Good must be also its final result or cause. It follows, therefore, that those apparent deviations from the fundamental order of creation, as expressed by its fundamental law, and the apparent shortcomings as to its ultimate result, which we term Evils, in regard to organised things, are—like the forces of those organised things,

the vital forces (134, 135)—derivative and contingent manifestations of the primary law and force. It is therefore true that Evil is only relative; that Good alone is absolute (307); and that all partial evil is universal good. Pain, although an evil relatively and contingently, is often beneficent as to its ends and results, and so leads the individual to Good, and to the well-being of the organism, more surely than pleasure itself. We shall see subsequently how pain is the sentinel of the organism, and ushers in or accompanies a series of vital changes, the end of which is the prevention of evil, or the restoration from illness to health. And it may be stated generally, that the law of design, aiming at a constantly increasing perfection, includes in its primary idea a struggle with imperfection. Or, in other words, a struggle with what we term Evil, or Imperfection, is the mode in which Divine Providence leads on to a higher and higher development of the Beautiful, the True, and the Good (311).

365. *Derivative Prescient Desires.*—When the idea of the future enters into the consciousness, the desire to be in some future state arises; this is the feeling of *Anticipation* or *Expectation.* Like all other states of consciousness, it may be either pleasurable or painful. When painful—*i.e.*, when the anticipation is as to a state injurious to the organism—it is the feeling of aversion, loathing, dread, fear; when the contrary, it is hope, pleasant expectation, or is often termed Desire simply. Aversion, as the desire to avoid, correlates hope or desire simply, as the desire to attain.

366. It follows from these considerations, that all the vital processes of organisms, whether vegetative, instinctive, or mental, are necessarily prescient in their nature. The teleiotic idea of the future is well mani-

fested in all the stages of development, for organs are developed (as lungs in the mammals) in anticipation of the needs of the organism. It is equally the predominant law of the vegetable and animal instincts, and is so strikingly manifested in the latter, in reference to the continuance of the individual and the species in Time and Space, that the study of them constitutes one of the most delightful branches of Natural History.

> "Who taught the nations of the field and wood
> To shun their poison and to choose their food?
> Prescient, the tides or tempests to withstand;
> Build on the wave, or arch beneath the sand?
> Who made the spider parallels design—
> Sure as De Moivre, without rule or line?
> Who bid the stork, Columbus-like, explore
> Heavens not his own, and worlds unknown before?
> Who calls the council, states the certain day;
> Who forms the phalanx, and who points the way?"*

367. The prescient correlations of the desires with anticipated vital processes is very well illustrated in diseases under certain conditions. Thus, persons who, in travelling, suffer from extreme thirst, dream, when they sleep, of gushing fountains and ever-living verdure. These are due to the hope or anticipation of the thing, and which is realised, in the Belief of the dreamer, by means of the teleorganic processes which correlate the prescient feeling of Hope or anticipation. In this way, indeed, all our desires are the causes of imaginations; the hoper is too often given to waking-dreams of things never to be fulfilled.

368. *The fulfilment of desire*, whether it be the avoidance of the object of fear, or the attainment of the object of hope, is a pleasurable feeling, and is termed *gratification, satisfaction, pleasure, joy.* The failure to fulfil is

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* Pope. *Essay on Man*, Epistle iii. l. 99.

associated with a painful feeling, known as *grief, sorrow, regret, disappointment.* The higher feelings in connection with the future are amongst the strongest and most varied of our nature. They are all, therefore, of interest, both because of the large amount of pleasure and pain they contain, and because of their great importance to human welfare. The interest in the future is at all ages, and among all people, predominant. Tales, and novels, and histories, derive their greatest charm from the curiosity they excite to know what will become of the hero or heroine; all human affairs are arranged with a view to the future, and, unlike all other animals, Man everywhere instinctively looks forward to a future beyond the grave. Philosophically, Prescience is the aim and end of all human science; for that is true science which enables us to predict and provide for the future (361).

SECT. IV.—*The Desire to Energize.*

369. The operation of the vital forces in conscious animals is associated with a feeling of energizing towards the end desired or designed. There are two principal ends aimed at—namely, Feeling and Knowledge, or a state of consciousness simply; and Action, or a state of motion of the organism as a whole or in part. The former act of energy is variously termed Sensation, Perception, Apperception, Conception, Thought, and generally the *Faculties;* the latter is the *Will.* The Will aims at the completion of all desires which are to end in results—*i.e., vis viva* (127). The Faculties are named according to the object aimed at, or of which a knowledge is attained. Every faculty implies, therefore, a desire to attain an end or ends of the law of design, and has consequently one or more teleiotic ideas (164) as its basis, as intuitions. Thus,

what Sir William Hamilton terms "the faculty of self-consciousness" has the intuition of unity as its basis; the faculty of imagination, the intuition of realisation of a thought. The faculty of attention is a highly compound state of volitional consciousness, in which, with the desire to know, there is an act of Energy as to both the apparatus of the senses and of thought. The faculty of memory is also a highly compound state, dependent upon changes in the vital forces, and, strictly, is no faculty at all, but a *capacity*. There are therefore two fundamental classes of volitional faculties to be noticed, according as the man is busy with knowledge or with action. These are VOLITION PROPER, and APPERCEPTION.

370. Fundamentally, volition is nothing more than the intuitional desire to energize carried into action. All the various machines of the body are so constituted that motor force (*vis viva*) is developed and applied to secure the ends for which it is constructed; or, in other words, to fulfil the general law of design. Now, in a vast variety of organisms there is probably no consciousness of the use of the motor apparatus, or of the direction of force to the attainment of the ends aimed at or designed; just as there is no desire or feeling of pleasure or pain. But when the organism feels a desire so to act, and is at the same time conscious of the act of energy, it may be said *to will*. Such an act of energy is volition.

371. If, therefore, this view of the nature of that state of consciousness be admitted, it follows that the Will is based on a fundamental intuition, and, as such, correlates the fundamental teleiotic idea of the application of force to secure a designed series of events with a view to a pre-determined end (130). Consequently it is an inevitable and necessary element of all conscious states, for it is subordinate to an inevitable and necessary end. It

is, in its simplest form, the feeling of the exercise of power.

372. Now, such a fundamental law and idea must have its derivative and contingent laws and ideas. Where there is no knowledge of the derivative laws and forces of creation and their ends, the feeling is that which coincides with an instinctive or automatic exercise of power. It is the "*quoddam Divinum*" of instinct (77). But when the organism has a knowledge of the ends aimed at, and of the means whereby the contingent and derivative forces may be directed to those ends, the feeling is that which coincides with a rational and free exercise of power. This is the "free-will" of some German writers—who distinguish between what is *freiwillig* and *wilkührlich*, or sensational will.* Now, in this sense of the term free-will, it is clear that the man becomes free in proportion as he advances in knowledge; and that, consequently, perfect freedom of the will is only compatible with perfect knowledge of the order of creation; or in other words, of the will of God as manifested in his Divine providence. Or we may say that a perfect rational will corresponds, as to knowledge, with the "pure reason" of creation, as developed in the ideas of the law of design; perfect instinct corresponds to the order of creation as manifested by the law, without any knowledge of its ideas. The attainment of a good and perfect end is the perfection of reason; the desire to attain that end, and the action appropriate to its attainment, constitute the perfection of morals. Between the unknowing automatic act without desire, as manifested in the instincts of plants, through the ascending series of states of consciousness of animal instincts and passions to the highest knowledge of means and ends, in their

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* Unzer's *Erste Gründe*, &c. p. 328, note.

highest relations in man, are manifested an infinite variety of modes of existence and thought, yet so continuous that we are baffled when we attempt to define their limits (14).

373. *Instinct*, in the largest meaning of the term, must be therefore taken to signify the energizing of the vital forces to ends; whether these be aimed at in the formation and development of organs, in nutrition and other vital processes fitted to continue the organism in existence, or in the adapted use of the various organs, so that the ends aimed at in the existence of the organism may be attained (77). Consciousness, we have seen, is not necessary to these various processes (345, *sqq.*); but amongst the organisms endowed with this faculty, the degree of endowment varies to an immeasurable extent, being at the one extreme identical with the highest cerebral and intellectual development, at the other with the lowest conceivable amount of simple feeling.

374. Now, whatever may be the degree of consciousness, it corresponds with the manifestation of the vital forces in time and space. So that the highest mental endowments coincide necessarily with the highest activity of the vital forces in the shortest time and in the most extensive material substratum (327); or, in other words, the highest energy of the various faculties, and the widest grasp of intuitional truths in each species, are dependent, *cæteris paribus*, upon the size and power of the vital tissues (in vertebrates, the encephalic centres) subservient to mental operations. It is the same with those corporeal states of consciousness termed "feelings," which are constantly associated with the reflex and instinctive acts, and which are dependent upon the same kind of tele-organic changes as the motor phenomena; so that intensity of feeling correlates intensity of motor force.

375. The fundamental motor feelings are Desire, Aversion, Pleasure, Titillation, and Pain; and of these the latter is the most important. If we say that these are the causes of the instinctive actions with which they are associated, we gain nothing; for they are not, in fact, and cannot be, true causes. The true cause is Vital Energy, or the application of force to ends, and this is teleiotic (279). That which is the cause of the Energy is also the cause of the Desire or other feeling. Hence the one can be taken to represent the other.

CHAPTER IV.

THE GENERAL LAWS OF EVOLUTION AND MANIFESTATION OF THE MENTAL FACULTIES AS ACTIVE POWERS.

We have already determined empirically the instinctive character of the moral and intellectual faculties, and brought them into the same category as the animal instincts.* It is now in our power to lay down the vital laws with which these faculties are correlative, and bring them into especial relation with the Rational Will, or the exercise of the Faculties as Reason.

Sect. I.—*The Cognitive Faculties.*

376. *Apperception.*—The fundamental act of energy in thought, considered as an act of the will, is the state of consciousness termed by the metaphysician "I think.' It is the expression of the unity of the individual in the act of cognition. Now, in all the mental faculties, the idea and intuition of unity is the fundamental causal element (332). It is, however, more particularly the basis of that most fundamental mode of active cognition which is common to all the cognitive faculties, termed Apperception by the metaphysicians; and as a knowledge of this fundamental mode of mental energy will elucidate the nature and laws of the faculties generally, it will be useful to examine it in its teleological relations.

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* Part II. chap. vi. "On Instinctive Existence."

377. The faculty of Apperception, or the act of Energy in thought, is the state of consciousness during which man attains to knowledge of a thing. The fundamental idea of the act is the union of the Many into One, as an object of *perception*, and the union in *relation* of that manifold One with another manifold One, so that another manifold One shall result as a *conception*. This is the synthetical unity of the metaphysicians; and hence it is a law of consciousness, that in perception the objective Manifold becomes the subjective One (62). The process correlates the fundamental mode of vital energy (290, 292). "Pure reason," says Kant, "is a perfect unity; and therefore, if the principle presented by it prove to be insufficient for the solution of even a single one of these questions to which the very nature of reason gives birth, we must reject it, as we could not be perfectly certain of its sufficiency in the case of the others."* And when Kant proposed, as the "universal" or fundamental "problem of pure reason," the question, "how are synthetical judgments *à priori* possible?" he only proposed, in another shape, the proof of the fundamental law of synthetical unity. "Before we can attend to several things," Professor Whewell remarks, "as like or unlike, we must be able to apprehend each of these by itself as *one thing*. It may at first sight appear that this apprehension results immediately from the impressions on our senses, without any act of our thoughts. A very little attention, however, enables us to see that thus to single out special objects requires a mental operation as well as a sensation."†

378. *Comparison.*—Now, although apperception is thus shown to be a manifestation of the unifying Energy im-

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* *Kritik der Rein. Vernunft*, Preface to 1st edition.

† *History of Scientific Ideas*, 3d edit. vol. ii. p. 95.

plied in the teleiotic idea of Unity, that energy is operative according to the law of Relativity (140, 141). In an act of synthetical unity two things are brought into relation with each other, as the relative and correlative, the universal and the particular, the *plus* and the *minus*, the one and the one. Now this implies the faculty of comparison and the fundamental intuition of the Dual in relation, or Duality (286). Hence Kant observes, "By the word *synthesis*, in its most general signification, I understand the process of joining different representations to each other, and of comprehending their diversity in one cognition." And again: "The same function which gives unity to the different representations in a judgment, gives also unity to the mere synthesis of different representations in an intuition; and this unity we call the pure conception of the understanding."*

379. *Deduction and Generalisation.*—It is necessary to inquire how a knowledge of the relations of the two things which in Apperception are put in relation and compared, is reached. Now, all our intuitional cognitions of things as perceptions, are made up of many elements; each perception, as of a tree, a leaf, a face, is made up of several parts, themselves multiple. These various units are either actually or conceivably sub-divisible, until we arrive at a point when they become atomic; or, in other words, we cannot conceive them farther divisible without destruction of their unity (118). The mental process by which we thus determine the elements of a cognition or perception is *Deduction*. It is obviously the intuitional manifestation of the law of dichotomy, whereby the Dual is reached (290). On the other hand, the re-combination or synthesis of many elements thus obtained, so as to form a new integer, or one-thought, *i.e.* integration (291), is

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* *Kritik der Rein. Vernunft*, Transcendental Logic, book i. § iii.

Generalisation, which is therefore the antithesis of deduction.

380. The conditions necessary to these fundamental processes of thought are identical with those necessary to Existence (202). Hence it is that while the teleiotic ideas of unity, duality, diversity in relation, and multiplicity, together with dichotomy or differentiation, and integration, with their vital affinities, are co-operative in these fundamental cognitive faculties, the intuitions of time, space, and number necessarily enter into the series of changes, and thus the whole constitutes an act of conscious unity.

SECT. II.—*Presentative and Representative Faculties.*

381. Thought has a twofold relation to the external world. *First*, There is a presentation of the order of nature *to* the consciousness, through the recipient mechanism constructed to that end. *Secondly*, There is a representation *by* the organism of the operations of the forces going on in consequence of that reception within it, through the representative mechanism constructed to that end. These two faculties are especially the basis of all the social relations of organism to organism.

382. *Representation* may be considered the final result of Thought, as it is the object and first manifestation of the law of design. For as we conceive the idea or thought to exist before the manifestation of it (147, 148), so we can only conceive that the thought arises that it may be manifested. This manifestation of a particular idea in phenomena is the *representation* of the idea in phenomena, after its *presentation* to the consciousness. Now, looking at the whole series of teleorganic changes as a constant flux of phenomena correlating successions

of thought (associations of ideas), we can consider the successive states of consciousness which arise as the *presentations* of the causal ideas to the consciousness, in virtue of which they are evolved as vital phenomena. But these presentations, becoming in their turn causal ideas, are themselves represented in phenomena; and so on in continual sequence.

383. Hence, these successional and alternate presentations and representations are twofold in their relations to the organism. *First*, They are internal, when they are reminiscences, trains or associations of ideas, feelings, beliefs, and the like, and are the *thoughts* of the individual. Or they may be external, when the ideas are manifested by their results upon the body—*i.e.*, the organs of external relation. These may consist either in changes of form or functions of organs, as when the gait and features become permanently modified in accordance with the modes of thought and feeling, and thereby physiognomical changes are evolved; or, *secondly*, They may be manifested in the varying actions of the individual. This latter representation or outward manifestation of the ideas, and the states of consciousness generally, is mainly effected by vocalisation, by emotional cries, by changes in the expression of the eye, by the varying combinations of the features, by movements of limbs, or by changes of function of the viscera, as occurs in the emotions and passions. In man, however, besides the fundamental method of vocalisation evolved into *language*, or human speech,* the hand, foot, and tongue, are used to represent ideas, notions, and feelings, by signs of various kinds, of which writing is the most

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* "Language is the express image and picture of human thoughts; and from the picture we may draw some certain conclusions respecting the original."—REID.

perfect, and of which painting or sculpture is the primary idea.*

384. *Imagination* is the faculty of Representation in correlation with the intuitions of Form, or of co-existence and succession in Time and Space (230). It deals, therefore, fundamentally, with the phenomena of the external world. It may consist either in a reminiscence of past experience of phenomena, as recollective imagination,† in which case substrata are re-awakened into activity by affinitive impressions, and it follows the law of association of Ideas; or it may be *creative*, and forms and successions of events not to be met with in the external world may be developed. The class of spectral illusions, and many of the phenomena of clairvoyance, are illustrative of the phenomena of reminiscent imagination; while in dreams, poetic or otherwise, in "spirit-drawings," and in the art-work of the insane, we have illustrations of the morbid or irregular action of the vital forces in developing the *creative* class.

385. *Repetition* in Representation and Imagination is a fundamental element of those faculties, in so far as they deal with Form in its largest sense, as the isodynamic manifestation in space of the operation of forces (234). It is manifested in the symmetrical multiplication of simple forms (247). As a vital process, it is correlative with repetition in series (302). It is not uncommonly manifested morbidly in insanity, dreaming, delirium, and even in the works of eminent artists. The great psychological characteristic of Martin's paintings is repetition in symmetry and series.

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* Compare Mr Morell's interesting exposition of this subject, "Intelligence as Representation," *Elements of Psychology*, Part i. p. 164.

† Sir William Hamilton's designation of the process.

386. *Orectic Imagination.*—There is a form of imagination which differs from the abstract faculty in being associated inseparably with Desire, and which it is of much practical importance to distinguish. As there is no name by which it is discriminated from the intellectual or cognitive Imagination, I have indicated it by the prefix *orectic* (330) (from ὄρεξις), a term used by Aristotle, Mr Harris, and Lord Monboddo.* In the higher desires, the thing desired is presented ideally to the consciousness (365), and therewith is combined a volition for the realisation of the orectic ideas as an Imagination; or the thing to be avoided is presented ideally to the consciousness, and thus an imaginary object of abhorrence is presented.

387. When these orectic representations have no correspondence with external events or phenomena, they are termed imaginary hopes and fears. If they be normal, and without any vivid feelings, they are termed thoughts of the future. This kind of thought is by far the most common state of consciousness. They belong to the class of prescient thoughts and prescient imaginations.

388. When the Representative faculty presents *past* events to the consciousness as recollective Imagination, and there is a strong feeling associated with it, the state of consciousness is termed Regret, Remorse, or Satisfaction, "Good Conscience," and the like, according as it is painful or pleasurable.

389. When the encephalic organs are abnormally active, and an orectic idea, imagination, or presentation, is tuhs developed in affinity with existing substrata, there will be a tendency to its automatic realisation or phenomenal manifestation. This is what occurs in prescient dreams and delirious ravings, and in electro-biological pro-

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* Sir W. Hamilton. *Lectures on Metaphysics*, vol. i. p. 185.

cesses, when, by suggestion, this class of states is developed in those already predisposed.* The same thing occurs in all the impulsive forms of insanity, when the volition is hurried away by a sudden desire or orectic imagination, excited by affinitive impressions applied internally or externally, and the judgment is wholly mastered by the vital forces.

390. This law of automatic representation of the presentations to the consciousness, designated "imagination," is in fact the general law which is operative in all the morbid conditions known as clairvoyance, "spirit-drawing," "spirit intercourse," and the like, and is nothing more than a modification of the law of presentation and representation of biotic ideas developed into noetic (163). Sir William Hamilton's doctrines as to this department of psychology are as profound as they are clear and true. On no subject in the range of metaphysical inquiry has he more admirably manifested his great powers of analysis than in his essay "On Presentative and Representative Knowledge."†

391. *Association of Ideas* is the orderly sequence of representations, and is therefore fundamentally the necessary sequence of the teleorganic changes that correlate noetic ideas, resulting from the action of affinitive impressions (300). In its primary form, the law is manifested in the immediate results which follow the integration of the sperm-cell and germ-cell, in virtue of the affinitive relation which each bears to each. Then it is seen in the consecutive evolution of tissues and organs in associated sequence, under the operation of affinitive impressions,

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* See illustrations of this principle in my paper "On Odylo Mesmerism," &c., *Brit. and For. Med.-Chir. Review*, vol. viii. (Oct. 1851), pp. 427, 430.

† Note B., *Supplement to Reid's Works*, p. 804.

such as heat, light, &c. (301). Next we have the same law manifested in the associated reflex acts which follow upon the reception of suitable *stimuli*—*i.e.*, affinitive impressions in relation with the proper nerves and nerve-centres (347). Then the entire group of the instincts and instinctive processes of animals show, as we ascend higher and higher, how entirely the organism is in affinity with its various parts, and with impressions derived from without; and how these necessarily and automatically, with or without consciousness, excite the successional changes in the nerve-centres, and the appropriate muscular movements, secretions, and other vital processes correlative therewith. M. Agassiz mentions a fact highly illustrative of this necessary association of affinitive impressions. He has seen the young snapping turtle snap at anything before it, with its eyes shut, and while yet in its shell, with the yolk-bag attached to it.*

392. Finally, in all mental states of succession of ideas we have manifested the operation of the fundamental law of design as manifested in phenomena generally —namely, an orderly development of sequences and co-existences in necessary relation to each other (32, 150); —a law which is alike manifested in the æonic development of organisms on the earth, and in the necessary continuance of phenomena which make up the life of the individual.

393. So also as to the phenomena of muscular action. The successions of ideas, whether we term them Reminiscences, Recollections, Imaginations, or Trains (52), are in as necessary connection with each other as motion is in necessary connection with affinitive impressions (reflex acts), or with ideas and notions (voluntary or volitional actions). In all these cases there is a series of

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* *Essay on Classification*, p. 89.

teleorganic changes commenced—usually by an affinitive impression, causing what is termed a *sensation*—which continues to spread onward and onward until interrupted by another series begun in like manner; and so on in continual succession. Consciousness is by no means necessary to these successional series of teleorganic changes in its substratum. Whether they shall end in feeling, thought, or action, depends wholly upon the character of the changes, and the kind of substrata in which they take place and terminate—*i.e.*, whether ideagenic or kinetic (326).

394. The laws of association of ideas in thought of Mr J. S. Mill are the laws of all vital affinities. (298, *sqq.*) 1*st*, "Similar ideas tend to excite one another." 2*d*, "When two impressions have been frequently experienced (or even thought of), either simultaneously or in immediate succession, then whenever one of these impressions, or the idea of it, recurs, it tends to excite the idea of the other." 3*d*, "Greater intensity, in either or both the impressions, is equivalent, in rendering them excitable by one another, to a greater frequency of conjunction."*

395. This law of *association*, when Desire is an element, is operative in all those feelings of sympathy and antipathy which are felt from mere instinct, or from no obvious cause. It is an oreetic association of ideas, and is wholly automatic. The teleorganic changes are in connection with substrata acquired perhaps during the experience of childhood, of which there is no reminiscence; or with those which correspond to latent consciousness, of which there is no recollection; or even with substrata deemed hereditary, and which correspond to intuitions and habits of the child acquired during the

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* *System of Logic*, vol. ii. p. 428, 4th edit. See also Sir W. Hamilton on "Mental Association," Notes D** and D***, *Reid's Works.*

lifetime of the parent (326). When, under these conditions of the individual, the affinitive impressions are applied, and the encephalon is in a suitable state for the development of the substrata, there will be an inevitable change from the "potential" to the "actual" (59), and what was latent in the organism will start forth into vigorous sequence—perhaps never again to cease but with the life. Abundant illustrations of these principles are to be found in all works on somnambulism, dreaming, mesmerism, &c.* Perhaps the class of mysterious sympathies and antipathies referred to by Moore in the following lines may be noticed as a special illustration of what is a matter of everyday observation,—

"Oh! there are looks and tones which dart
An instant sunshine through the heart;—
As if the soul that moment caught
Some treasure it through life had sought;
As if those very lips and eyes
Predestined to have all our sighs,
Sparkled and spoke before us then
Never to be forgot again!"†

396. *Imitation.*—This is a fundamental faculty, allied in its origin to presentation and representation. It is essentially the representation by the organism of the form and appearance of things external to it.

The primary law of Imitation is biotic, and is shown in that automatic tendency which many animals and even plants manifest, to take on both the form and colour of surrounding objects. This is essentially a change in the vital processes. It is a phenomenon which has attracted a good deal of the attention of naturalists.

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* See my essays "On the Reflex Function of the Brain," *Brit. and For. Med. Review* (Jan. 1845); and "On Odyle Mesmerism," &c., *Brit. and For. Med.-Chir. Review* (Oct. 1851).

† *Lalla Rookh.*

The latest inquiry into it is that of Mr Murray.* One very common observation of this kind is, that the colour of an animal is assimilated to that of surrounding objects. The hare is like the "benty braes" it sits on; the grouse like the heather in which it couches; the partridge like the stubble it hides in. Fishes take the colour of the stones or bottom of the water they live in; the tree-frog and lizards, of the green leaves amongst which they hide; snakes are in colour like the grass or stones amongst which they glide. A spider has been seen to change from black to white on a newly white-washed wall.† The variable changes in colour of the chameleon, under instinctive feelings, is a familiar fact.

397. Some of these instances are probably illustrations of the primordial instinct of deceptive imitation, and are part of the instinct of self-defence; but others are more probably examples of the operation of affinitive impressions. For it is found that there is an innate tendency in animals to imitate motions, gestures, sounds. The mocking-bird, parrot, and monkey, afford well-known illustrations of this law. In man it operates automatically, in assimilating an individual in voice and manner to those amongst whom he lives, so that he sooner or later catches a movement, tone, "brogue," or accent, peculiar to the people. In this way husband and wife are sometimes so influenced by each other as to attain to a general resemblance to each other.

398. This imitative faculty is most obvious in the excitation of gestures and feelings in one individual by the manifestation of them in another. Thus, yawning

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* "On the Disguises of Nature; being an Inquiry into the Laws which regulate External Form and Colour in Plants and Animals," *Edin. Phil. Jour.* (Jan. 1860), p. 66.

† The *Naturalist* (Aug. 1854), p. 167.

and laughing are contagious: if you would make a man or even a dog angry, frown at him; if you would allay his anger, smile. Nothing is more certain as a psychological law than this direct causal influence of gestures, looks, manner, and all the phenomena which express the emotions of one individual, in exciting them in another. It is in fact the foundation of successful oratory and dramatic art, and even of public exhibitions, the success of which depends upon the gratification of the public. In private as well as in public life, it is a master-key to the exercise of influence over men, and is used by many with remarkable success. Nowhere is it so available as in asylums for the insane. In these cases there is a strong feeling intermingled; the imitation is *orectic*, but imitation may be developed simply as a representative Act. As a general rule, this is not a mark of high intellectual endowment.*

SECT. III.—*Volitional Faculties.*

399. Now in all these modes of operation of the fundamental intuitions, there is a desire to energize to attain the end desired. This is twofold: namely, first to know, or have a presentation to the consciousness; secondly, to represent the knowledge by act. The first mode of energy is termed attention, the second volition.

400. *Attention* is obviously an act of the will, whereby the instruments of knowledge are put into relation with the things to be known. 1. There is the organ itself, as the eye, or the ear, or the hand as the instrument of touch,—the muscular apparatus of which is appropriately but instinctively brought into the best

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* See illustrations of these views in my paper on "Odyle Mesmerism, Electro-Biology," &c., *Brit. and For. Med.-Chir. Review*, vol. viii. (Oct. 1851), p. 428.

state for the reception of impressions appropriate to the organ. 2. Next the nerve is exalted in function, so as to become more sensitive to affinitive impressions; and, 3. The encephalic or ganglionic tissue itself has its functional activity developed. It follows, therefore, that in an act of attention a series of changes takes place in the organisation itself, all of which consist in increased functional activity. Now, we know that such activity is due to a more rapid circulation of blood through the part, and more frequent modification of the tissues with which it comes in relation. Hence the proper function of the faculty of attention is to develop the vital processes of the organs involved in its action.

401. *Motor Volition*, or *the Will.*—The other form of volitional energy, which is to be distinguished from attention, is that state of conscious energy when the muscles are put into action in accordance with the feelings, desires, or cognitions; so that motion of a limb, or of a body external to the organism, results. We have already considered this act in relation to the Desires and Feelings (367, *sqq.*); we have now to examine it in relation to the higher states of consciousness, as the WILL, or rational will;—the "I will," as opposed to the "I think."

402. We have seen that every conscient act of energy is preceded necessarily by its cause. A biotic idea, correlating a noetic idea, must therefore precede every act of Will; that is to say, the intent as to the future (360) arises in the consciousness before the state "I will" passes into act. This includes two things—a perception of the end, and a desire to attain it. Then comes the desire to energize to that end—*i.e.*, the attainment. So that an act of self-conscious rational will comprises at least four elements.

403. Sir William Hamilton, in examining the mecha-

nism of voluntary movement, distinguishes only three elements in a volition: "*Primo*, The universal or purely mental act of will; what, for distinction's sake, I would call the hyper-organic volition to move—the *actio elicita* of the schools. Of this volition we are conscious, even though it do not go out into action. *Secundo*, If this volition become transeunt—be carried into effect—it passes into the mental effort, or *nisus*, to move. This I would call the enorganic volition, or, by an extension of the scholastic language, the *actio imperans*. For we are conscious of it, though, by a narcosis or stupor of the sensitive nerves, we lose all feeling of the movement of the limb; though, by a paralysis of the motive nerves, no movement in the limb follows the mental effort to move; though, by an abnormal stimulus of the muscular fibres, a contraction in them is caused even in opposition to the will. *Tertio*, Determined by the enorganic volition, the cerebral influence is transmitted by the motive nerves; the muscles contract, so that the limb moves or endeavours to move. This motion, or effort to move, I would call the Organic *nisus*; by a limitation of the scholastic term, it might be called the *actio imperata*." *

404. In this analysis of the order of phenomena, the desire, which according to my views precedes the "hyper-organic" volition, is omitted. That such a desire is a necessary antecedent, is, I think, deducible from the phenomena of certain cases of so-called hysterical paralysis, in which there is no imperfection of muscle, nerve, or kinetic substrata, but simply an absence of all desire to will. When emotion intensifies the process, then it is found that the patient, helplessly paraplegic, perhaps, for months, can use the lower limbs with vigour. This kind of volition is a form of instinctive volition. It may occur

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* *Supp. Dissertations to Reid's Works*, Note D, sect. ii. p. 863, note.

independently of any clear perception of the end, or without any perception, indeed, at all; and in this case even the desire itself may only be an *actio elicita*. An organism may conceivably desire to *be* happy, but may not desire to act to *attain* the desirable state. Hence we can distinguish a state of volition intermediate between unconscious automatic actions, and that kind of will which is accompanied by a strong desire, without knowledge of the end or of the means to attain it. This is "sensational" will, being usually accompanied by sensations (338).

405. *Intellectual Will, Reason.*—In a higher development of the conscious act of energy, the faculties by which knowledge is attained, or intuitions evolved into experience, are deeply involved, inasmuch as, when knowledge is added to the desire to act to certain ends, it is perceived how or why the pleasurable can be attained, or the painful avoided; and all the knowing faculties are concentrated on the how or the why. It is the ultimate act of Energy, as indicated by the "I will" of the metaphysician. Moralists have usually treated of this earnest pursuit of happiness, or of the avoidance of pain, as the mainspring of all human actions, as in truth it is; but many have propounded the doctrine with such limitations as have tended rather to degrade human nature than to elevate it. It is true that the majority of mankind desire only sensual gratifications; but it is not the less true that man is capable of desiring the highest moral and intellectual pleasures. His desires extend, in fact, to all the ends aimed at in the great law of design; and consequently, desires to attain the highest ends of his existence are potentially present in his nature, requiring only a fitting development to awaken them into consciousness, and guide his actions. If the end be perfection, man constantly struggles after perfection; if

unity, he seeks unity; if to manifest the Divine attributes, he seeks to discover the Divine attributes, and to have fellowship with the Divine. Nothing can be more simple and more certain than this teleological law of the desire to energize, or the Will. The desire for Perfection (312) is the correlative of the highest development of the reason, as manifested in the human will. This is therefore the essential principle of all the great questions of social progress and of individual happiness.

SECT. IV.—*General Summary.*

406. From these doctrines we may deduce some useful general principles. It is obvious that the mental powers can only be manifested according as the substratum within which they act is developed by the vital forces in relation with the teleiotic ideas; in other words, if there be an individual without an organ in which the intuitions are or can be manifested as causal ideas, he can have no understanding.

407. If any of these intuitions be defective, then the individual, as to that class of ideas, is defective in one or more mental faculties; if any of them predominate, then that predominance, manifested in thought and act, is the expression of his individual character.

408. If it so happens that the internal sequences and co-existences, in or by which the organs of the Faculties are built up, be the perfect results of the teleiotic ideas, then the intuitions correspond in their character, and are absolutely true. But such perfection, although manifestly aimed at in the law of design, and probably attainable under favourable conditions, is seldom if ever reached. Man comes sadly short of this "high estate" and perfect model, and is incapable of grasping all truth intuitively.

Occasionally, however, men are born who possess this power partially—*i.e.*, with reference to particular intuitions, in virtue of which they possess special faculties in high perfection. These are the "men of genius," the heaven-taught poets, musicians, metaphysicians, painters, philosophers. To the rest of mankind, who themselves see truth but as in a glass darkly, such men often seem to be "inspired"—that is, to possess a source of supernatural power, or to receive their knowledge direct from God.

409. Again, with reference to the contingent and variable cognitions which make up the sum of the experience of a man's life, and which are "stored up" in his memory, or the elements of which have been transmitted as acquired intuitions from his parents and ancestors, as modes of action of the mental faculties, or some of them. If, in these cases, the intuitions, or any of them, are only potentially present (59)—*i.e.*, if there be correlative (or ideagenic) substrata, and the impressions arising from experience have never reached them—then the mental faculties will be dormant, until external circumstances or internal vital changes excite the substrata into biotic activity. By this process the unconscious will be brought into consciousness (60).

410. It would be easy, in this way, to apply these general laws of the intuitional powers to the illustration of the laws of action of ideas, as causes of both vital changes and correlative mental processes. This, however, is no part of my present plan; to attempt such development of the doctrines would be to undertake the construction of a science of Ideology. It may be useful, however, by way of illustration, to indicate in a general way how the teleiotic ideas, considered as fundamental intuitions, are alike the causal ideas of cerebral development, the source of all experience, and the fundamental ideas of the sciences.

CHAPTER V.

FUNDAMENTAL CORRELATIONS OF THE LAWS OF GROWTH AND DEVELOPMENT AND THE LAWS OF THOUGHT.

411. Before entering more specially into the correlations of the laws of Life and Thought, it is necessary to examine them as the mental forces which are manifested in the development and functional activity of living tissues in general, and in the cerebro-spinal centres in particular, as the proper substratum of mental operations.

Sect. I.—*Evolution of the Organismic Tissues as the Substratum of the Mental Faculties.*

412. The fundamental energy of the law of design is the *realisation* of the teleiotic ideas in Time and Space. In living and conscient organisms, these teleiotic ideas, as derivatives of the fundamental idea, are both biotic and intuitional. They have therefore a twofold operation—*first*, as vital forces acting on the material substratum, so as to shape and arrange its ideagenic and kinetic *substrata*, the changes in which will be coincident at some future time with states of consciousness, but which do not necessarily enter into the consciousness at the time of formation and arrangement (latent consciousness, 63); *secondly*, on the consciousness—or mental forces proper—exciting its various states known as Feelings, Desires, Intuitions, Beliefs, Faculties. In both kinds of

relation their fundamental law is that of evolution from the most general to the most special (162), but always under the condition that the special includes the general (156); a law, we have seen, that is equally the law of Life and of Thought (chap. vi. § 2), and which has been fully recognised as the law of organic development.

413. The development of the organic basis of the vital powers, and the evolution of the substrata of the knowing faculties, both follow the same law. First we see the simplest evolution of the combined action to unity of the various fundamental processes whereby life is maintained in an organism of the simplest form, as a zooid or polype. Then, as we ascend the scale, and differentiation of tissue takes place, there is a correlative manifestation of the fundamental or teleiotic ideas, and instincts of plants or animals appear, with their appropriate instruments and *vital substratum*. As we ascend still higher in animal life, the instincts gradually lose their unknowing character, and the mental faculties emerge, with their appropriate organic basis in the encephalon, and their appropriate vital mechanism or instruments. Finally, with the highest evolution of the biotic ideas we find Man in his highest development; evincing in art and science the results of the operation of mental powers, which in the lower animals are purely instinctive, in the lowest organisms simply vital processes. The derivative teleiotic ideas have become completed as noetic ideas or cognitions; the Intellect is supreme.

414. Hence it follows, that, while every fundamental intuition, as the correlative of a teleiotic idea, is the noetic basis of a corresponding mental faculty so-called, or group of faculties, it is also the evolutional cause of a corresponding encephalic tissue, or group of tissues—*i.e.*, of their vital substratum—together with the corre-

sponding mechanism of external relations, constructed to be in affinity with external phenomena, namely, the organs of the senses. And as these various machinery are developed and worked in accordance with the law of evolution of causal ideas (155, *sqq.*), and all their vital processes are dependent thereon, however contingent and variable they may be, the fundamental intuitions become evolved into experience, the formularised results of which constitute a corresponding science and art, or group of them. This doctrine, therefore, of correlative biotic and noetic evolution, is the basis, on the one hand of a science of MENTAL ORGANOLOGY, and on the other of a science of INDUCTION. Without the mental causes operating as biotic ideas, there can be no development of a proper *substratum;* without the correlative *substratum,* there can be no manifestation of mental powers, and no cognitions, whether primary or derivative.

415. Now, the results of these Energies, whether physiological or mental, are all necessary, as we have already seen (174, *sqq.*); and this quality of necessity attaches to them whether they be merely instinctive energies in the limited sense of the word, or whether they are known as intellectual instincts or mental faculties (74). The intensity of the manifest phenomena has no necessary reference to intensity of feeling; for, whether they be accompanied with consciousness or not, that is regulated by the amount of the force used in carrying on the teleorganic changes; and the extent of these, again, by the character of the causal or teleiotic idea. Now that is manifested primarily in extent of development; for in proportion to development is the multiplicity of parts, and therewith that functional activity which is needed to regulate all the phenomena of the organism. In any case, there is a realisation of the idea by force in sub-

stance. In unconscious organisms, it is realised in form and function only; in the conscious, it is realised as a representation to the consciousness—or rather, is itself realised as a state of consciousness. If realised without further change, there is no act of motor energy—that is to say, no volition; in this case the realisation in the consciousness is limited to Thought, and is specifically termed an *idea* or *notion*. When the idea is coincident with an act of motor energy, it is termed a *motive;* in this case it is realised in the actions of the organism. In either case, the phenomena are only the conscious result of the ideas and correlative teleorganic changes in the nervous system; which themselves are the result of the vital forces operating thereon according to a teleiotic idea, primary or derivative.

416. The various modes in which teleiotic ideas are realised in consciousness have been long recognised as modes of conscious energy, and designated Faculties, or Powers of the Mind. They vary widely in genera, species, and individuals, according to the ends of the existence of the organism, and its correlative relations in Time and Space. The best—but by no means complete—psychological arrangement of the Faculties and Powers is the phrenological arrangement, first begun by Gall, and afterwards extended and modified by Spurzheim.

417. Now, each Faculty, Power, Instinct, Sentiment, or other mode of Energy—no matter what—is manifested according to the same laws. And since all the primary representations of teleiotic ideas without consciousness consist in the teleorganic changes in organisms—that is to say, the vital phenomena which go on without consciousness, and which are manifested in their results as nutrition and development, or as automatic and instinc-

tive acts—it follows that the fundamental ideas may be realised either with or without consciousness (345, 346). Realised with consciousness, they have their highest development in the arts and laws of mankind; realised unconsciously, their highest development is manifested in the constructive arts and social instincts of the lower animals. The formation of a perfect statue by the hand of genius, and the growth of the living form which that statue represents, are both effected according to the same idea. In the one case it is manifested as an ideal intuition of genius, in the other as an archetypal idea of development (239). But whatever may be the mode of evolution and manifestation of the intuition, the law of nutrient energy and growth of tissue correlates the mental process; so that there is an evolution or development of the material organ—the encephalon—coincidently with the evolution of the idea in the mind of the artist, and its material or visible realisation in time and space.

SECT. II.—*Fundamental Affinities of Organismic Tissues.*

418. The intuitional organisation thus evolved is in relation—*first*, to the phenomena of external nature; *second*, to those of the internal nature of the organism itself. In either case, the teleorganic changes in the organism, of which the intuition is the causal idea, are guided by a series of vital affinities appropriate to the intuition. Thus the eye, as the instrument for the reception of the forces of light, or the ear for those which cause sound, is in connection with a nerve which is in vital affinity with the vibratory movements upon which light and sound depend. This nerve, again, is in such structural or vital affinity with suitable substrata in the nerve-centres, that the changes it undergoes from the

impulse of "affinitive" molecular forces become themselves the immediate antecedents to—*i.e.*, causes of—a wave, or series of waves, of teleorganic changes in the substrata, with which correlative conscious states and vital or nutrient changes in the tissues are associated. These may be an act of feeling simply, or a sensation, or a reflex act of limited extent. If, however, the waves thus excited in the substrata are carried on to other substrata in vital affinity with them, they will excite a fresh series of waves in those other substrata; and the whole, when evolved *noetically*, constitute *trains* or *associations of ideas.*

419. Now, in every case, when a series of vital affinities are thus put into operation, the order of events is precisely analogous to that which is seen in chemical affinities occurring in succession, so far as the transference of force is concerned (296–300). When once the series of vital waves are put into motion, the transference of force begins, and it must therefore end somewhere in the expenditure of force. This is the law of all motion. When the processes are purely vital, the termination is in motion simply, of which muscular power is the type (128); when, on the contrary, the processes are purely mental, the waves pass on and on, through a series of highly differentiated tissues—the cerebro-spinal ganglia—and the results are such changes as accompany or coincide with states of consciousness. Hence a developed tissue is necessary just in proportion as the states of consciousness are intense, or the relations of the organism manifold. It is in this way we can comprehend how affinitive impressions will excite violent reflex acts in one animal, when the continuity upwards of the spinal cord is cut off—the transeunt force not being expended in the encephalon; while in another, in which

the continuity with that highly differentiated mass of nerve-tissue is maintained, no reflex movement of limbs can be excited—*i.e.*, no muscular power is developed. In this case, the transeunt force is expended in the encephalic tissue as cerebral force.

420. Nevertheless, it is not the results of each wave that become an object of consciousness, but only a series of them in teleiotic succession, ending in a suitable ideagenic or kinetic substratum. And even these need not necessarily be objects of consciousness; for if there be no expenditure of force in the development of the substrata (they being already developed, as in habits), consciousness may be at a *minimum*, or the force may pass wholly outwards into the muscular or other motor systems, as the viscera; or be expended in the vital processes of the tissues in general.

421. It is obvious, from these considerations, that the laws of vital affinity must constitute the basis of a true physiological psychology, just as the laws of chemical affinity constitute the foundation of chemical science. And I may here add, that such were the doctrines which I formerly developed, in their application to cerebral action, under the term "reflex function of the brain," and which have since been designated "unconscious cerebration"—a term not happily chosen.

422. This law of growth and evolution of the material substratum of the mental faculties, according to laws of vital affinities, is no more surprising, and no more difficult to comprehend, than the archetypal law of development of entire organisms in time and space. It is in fact in all respects identical with it, except that in thought and will the vital processes are restricted to the invisible hidden structures of the body, while in the organism they are seen as visibly developing many parts

in integration. It is only a continuation, in short, of the same law of expanding relativity. As the external relations of the organs extend, so also there is a continual and infinitely varied development of organs in adaptation to those relations. As the expansion widens consciousness is evolved, and therewith the mental relations of the individual to the causes of his existence are evolved; until the highest evolution is attained in a knowledge of God as the First Cause of all things, and of His relations to the individual, and to creation at large. As the mental relations are evolved, the organisation is evolved *pari passu;* for without a phenomenal realisation, there is no realisation of mind at all. In man it is the encephalon which culminates in structure with the culminating development of the faculties. Consequently the laws of development and function of the encephalon, as the organ of thought in the individual, must correlate the laws of life, organisation, and development in general. This principle will therefore be our guide in our inquiries into the first principles of a MENTAL ORGANOLOGY.

SECT. III.—*Organismic Evolution of New Instincts and Faculties in the Species.*

423. We have already examined the general laws by which the varying changes in form of organisms are effected, so that variations from the specific form result.* It was then established that incessant change is as much a law of development as unity of type; and consequently, that, within the limits of the type, no two individuals are in all points alike (250). Now this variation in form, it was seen, was both physiological and developmental (or morphological, in the restricted sense),

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* Part III. chap. ii. § 3. vol. i. p. 355.

but that the physiological was in fact only the necessary antecedent or cause of the morphological; in other words, that the two classes of phenomena were really in relation.

424. Since the development of new instincts and faculties must necessarily concur with changes in the form of the individual or the species, it will be well to examine more specifically the operation of these vital affinities in the evolution of new substrata, and therewith in the modifications of form, features, and expression. The fundamental law of their operation is obvious; for since the results of the vital forces are only manifestations of the general law of adaptation to ends, it necessarily follows, that the continual operation of those forces in teleological relation to external conditions must be continually modifying the substratum of conscient states, and guiding its nutrition and growth in accordance with this relation. Now, we have two modes of manifestation of these operations; namely, *first*, in the phenomena of memory and habit of the individual; *secondly*, in the phenomena of memory and habit of the species, as new instincts.

425. It is to be remembered, in considering this question, that the same law of teleiotic formation of tissue applies to the operation of *all* the derivative, variable, and contingent ideas, as applies to the fundamental intuitions from which they proceed. The same law of evolution by which the organs of the organism are developed in adaptation to the external world and to each other, operates in the continual changing processes of life and growth. In this way, ideagenic and kinetic substrata (326) are being continually formed in biotic adaptation to new external conditions and to each other. It is thus that in lower animals new instincts are formed,

and in the higher all those changes induced upon which memory and the association of ideas depend. Without this correlative evolution of the ideas in the growth and nutrition of the appropriate substrata, there could not, in fact, be that continual sequence of conscious states by which memory and habits are developed, and upon which personal identity depends. This leads us to think that the common observation, which connects strength of memory with size or extent of tissue and vigour of vital force, is founded on fact. On the other hand, it is probable that in lower organisms, where there is no evolution of a proper tissue, there is no memory, but habit only; the recurrent acts are either strictly automatic or merely sensational.

426. The ganglionic or encephalic tissue thus evolved by derivative ideas, acquires its own vital affinities, both of external and internal relation. When these become part of the transmissible and transmitted elements of the organism, the offspring becomes capable of receiving the same kind of affinitive impressions as the parent, and of experiencing the same kind of modifications of the vital processes (261). Hence it happens that the same impressions which excite a sensation, reminiscence, recollection, mode of action, muscular movement, or vital process in the parent, will induce somewhat similar phenomena in the offspring. And as these are not the educts of experience in it, and consequently constitute no part of its personal identity, they will be manifested in consciousness as connate modes of thought or habit, or assume the characters of obscure intuitions, or will appear something like glimpses of a mysterious pre-existent state of consciousness.

427. To what extent this transmission of what may be termed ancestral intuitions and modes of thought—the

educts of ancestral experience—takes place, is hardly guessed at, and has, I believe, never been made matter of observation. A few general notions have been expressed—such as that a child of educated parents acquires knowledge more quickly than a child of uneducated; that the child of parents who have lived so long in a foreign land as to acquire a familiar knowledge of its language, will more readily acquire a knowledge of the tongue of the native country of its parents than one born of parents belonging to their adopted country; and so on. No thought has been given, I believe, to the fact that such transmissions may date from a long antecedent period in the history of mankind, extending indefinitely into the past (151).

428. Thus, then, we trace the operation of the same laws of unity and permanence with variety and change in the physiological and mental processes of both the individual and of the species. And as the teleiotic ideas are being constantly realised in Form, we see how these physiological processes may develop changes in the features, gait, size, and other particular characteristics of the individual, which will be transmitted from generation to generation, for the same reason that the archetypal tendencies are transmitted; and how, under the influence of external conditions or of mental faculties operating steadily from generation to generation, apparently new races and new species may be at last evolved (250).

429. The development of these new vital affinities has some important practical relations to physiology and pathology. It is permanent and extensive, for example, in proportion to the duration and amount of the vital forces they put in action; hence new instincts are most readily evolved in animals or plants which are submitted to the influence of new external conditions from the earliest period of their existence. And this is also shown

to be the law of memory in the individual. If old age, with its feeble vitality, be characterised by decay of the vital processes, and, correlatively, with decay of the memory and mental faculties generally, youth is marked by a correlative evolution of both, until with puberty the man attains his highest development. Memory is not at the best in mere youth; on the contrary, in infancy it is very defective, while it manifestly improves as age advances. The influence of established puberty, on the intellectual faculties as well as on the sentiments and passions, is very striking. At this period they often manifest a sudden development, so that a youth almost imbecile previously, or markedly defective in mental power, becomes, concurrently with the completion of the organisation, more vigorous in intellect. After puberty, the memory remains good, because until middle age the vital powers do not necessarily experience any diminution, while the mind itself is being expanded by the lessons of experience. Nevertheless, it is obvious from all the facts of hereditary transmission of mental power, that a certain size of the encephalon, and therewith a certain order of development, are transmitted from parent to offspring, with the hereditary tendencies to certain mental manifestations, whether they be good or evil.

430. It follows, therefore, that while the encephalon thus grows in accordance with the often repeated modes of thought and action of the individual, and with the physiological correlations of memory, fixed ideas, habits, and mental associations are developed at the same time, which may be transmitted hereditarily. Such teleorganic conditions of the substratum of Mind are virtually, in fact, in the same category as the original tendencies of the individual; so that when appropriate impressions reach the encephalon, the correlative vital changes are induced;

and thus past modes of thoughts are re-excited, as recollections or fixed ideas; are excited into activity as motives; or established modes of muscular action are re-excited as habits. It is in this way, then, that new instincts are developed and transmitted, and new modes of vital action, whether in the vegetative or mental processes, are formed as hereditary tendencies. Such is the law of the hereditary transmission of a tendency to insanity, drunkenness, and the like.

431. I mooted these views some years ago, when applying the doctrine of ideagenic and kinetic substrata. In particular, I laid down these general principles regarding this class of acquired substrata: "In the *first* place, it is to be observed that they are as invariably transmissible from parent to offspring as any other portion of the system, and are subject to the same laws of development. They are therefore as much a part of the animal as its nerves or blood-vessels. *Secondly*, These ideagenic and kinetic substrata may be modified, as any other organ of the body, by intermixture of species or genera, or new substrata may be formed by the reaction of external stimuli on those already existing; or, in other words, new instincts may be acquired and be transmissible. *Thirdly*, These substrata may be persistent as a part of the organism, and continue to be manifested by acts, long after the necessity for those acts, as conservative of the individual or the race, has ceased. *Fourthly*, These substrata may be dormant for a lengthened period from the absence of the re-agents, and so appear to be extinct, and yet will reappear so soon as the impressions adapted to their action are received by, and conveyed along, the afferent nerves. *Fifthly*, As there is a general development of organised beings as well as of races, those substrata which are common to all will be the most

indestructible in each, and the instinctive acts of which they are the basis, the most decided and permanent."*

432. Illustrations of these laws abound in works on Natural History. Thus the various breeds of dogs, for the chase, the gun, or other purposes to which man puts that animal, all indicate the transmission of acquired instinct, inasmuch as a "well-bred" dog means a dog which has the acquired instinct in perfection hereditarily. Mention is made by Moore in his diary of a curious example of this kind:—"In talking of handwriting [at Lord Denman's], and its being sometimes hereditary, Brougham said that he had found some of his grandfather's which exactly resembled his own, though the grandfather had died before he was born, and his father's writing was altogether different."† Nothing is more common, in fact, in families, than this kind of transmission of minute traits of mental character or habit, from generation to generation.

SECT. IV.—*Organismic Degradation of Instincts and Faculties.*

433. When developing the laws of action of the causal idea of Perfection (305), the correlative ideas of Imperfection and Disorder were examined. I have already noticed the hereditary transmission of a tendency to insanity, as a morbidly imperfect state. We have to consider organismic degradation to a lower type.

434. Although the primary law is that of expanding development in proportion to the multiplication of external relations, with the object of higher and higher per-

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* Essay "On the Reflex Function of the Brain," *Brit. and For. Med. Review*, Jan. 1845, p. 308.

† *Memoirs, &c. of Thomas Moore*, edited by Lord John Russell, vol. vi. p. 66.

fection, it must not be forgotten that there are deviations from the law, in which there is a morbid or abnormal recession in the adaptation to external relations. This is seen in monstrosities, and in races of men or individuals who have degenerated from a higher type, from the influence of morbid agents; whether climatic and domestic, as in the Cretin, or the savage, half-starved tribes of Australia, or whether dietetic, as in degradation, physical and moral, from drunken habits.* To this point I allude in the paper already quoted from, remarking (p. 309), "Just as monstrosities and physiological changes occur, marking a retrograde step to a lower form of organisation, so are the substrata of lower instincts developed and excited into action. A perfectly idiotic girl in Paris, having been seduced by some miscreant, was delivered of a child without assistance. It was found that she had gnawed the umbilical cord in two in the same manner as is practised by lower animals." The evolution of lower ideagenic and kinetic substrata is by no means an unusual phenomenon in the idiotic, especially the congenital idiot. Many of the habits and instincts of lower animals, and even the same kind of vocalisation, will be reproduced in these degenerate specimens of humanity.

435. Nor are these changes uncommon in the individual as morbid states. The insane who fall into a state of *dementia* often manifest mere animal instincts of a peculiar kind; and even persons not demented. I have shown the development of instincts of this class to occur in certain forms of hysteria and hysterical insanity.†

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* *Vide* Morel, *Traitè des Dégénérescences de l'Espèce Humaine.* 1857.

† *Treatise on the Nervous Diseases of Women* (1840). part i. chap. iv. and part iii. chap. viii. § 2. Practical illustrations of these doctrines constitute part of my collegiate course of Medical Psychology.

436. Various other changes in the brain, of a degenerate kind, also influence the individual. Thus, the development of brutal habits is a well-known result of habitual intoxication, so that the instincts of the savage, or even of the ferocious beast, crop out.* Age has apparently a similar effect on some men; in monkeys the change is particularly manifest, the animals becoming morose, sullen, and vindictive, as age advances.†

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* See my Essay "On Oinomania," *Jour. of Psychol. Med.*, vol viii. (April 1855), p. 185.

† This is observed to be particularly the case with the Semnopitheci apes in tho Zoological Gardens in London. Vimont correctly remarks that the same changes take place, in a less degree, in old dogs. (*Traitè de Phrenologie*, tom. i. p. 185, note, and p. 247.)

CHAPTER VI.

GENERAL DOCTRINE OF THE FACULTIES, FEELINGS, AND BELIEFS, AS EXPERIENCE.

437. The foregoing doctrines have had mainly in view the fundamental powers or faculties whereby knowledge is attained. It is necessary, however, to develop more particularly the correlations of these faculties, and their coincident feelings, with those incessant changes in the material substratum which are the basis of all that is variable, uncertain, and fleeting in our states of consciousness, and which constitute, as a whole, the experience of the individual. Every teleiotic idea correlates in the consciousness a primary intuition; and each primary intuition. considered as a causal idea, enters into a long series of derivative ideas, which it evolves through, or on the occasion of, experience of the external world, arrived at primarily by means of affinitive impressions. When these derivative ideas are evolved into the consciousness as noetic ideas, notions, general results, and the like (163). and are systematised and formularised, they constitute the general principles of science or of experience, according to the method followed (vol. i. pp. 90, 91). If the method be scientific, and if it be successfully carried out, then these derivative ideas of a fundamental intuition constitute the body of scientific truth and knowledge, or the science of those phenomena with which the mind has been occupied. It is only in the method, therefore, that

there is any difference between the two forms of knowledge,—the principles of SCIENCE, and the principles of EXPERIENCE.

438. The fundamental intuitions of science are termed Scientific Ideas; they concern external nature mainly: the fundamental intuitions of experience are termed Beliefs, or Intuitive Truths; they refer mainly to the relations of the individual as seeking to attain happiness and good, or to avoid pain and evil. The one class are the basis of abstract cognitions; the other, of orectic cognitions, or what are often denominated "the Feelings."

Before proceeding to examine the feelings termed Fundamental Beliefs in their relation to experience, it will be well to take a general view of the various feelings and instincts which make up the mental life of man, as experience.

SECT. I.—*General Summary of the Feelings and Faculties of Experience.*

439. The phrase "the feelings" is a designation of conscious states of relation to external things, in which a strong feeling of pleasure or pain, or strong desire or aversion, is predominant. But it is also usually made to include modes of consciousness known as propensities, instincts, sensitive affections, desires, lusts, passions, sympathies, antipathies, sentiments, and other relative states of consciousness. Thus, men speak of a "propensity" to imitate, to steal, to destroy; of the "passion" of anger, love, hatred; the "lust" of revenge, the "affection" of grief, the "emotion" of joy or of hope; the "sentiment" of reverence, pride, modesty, or approbation; the "desire" for sympathy, for gold, for knowledge; the "feeling" of revenge, of terror.

440. These states of consciousness, in which the organism is in relation to the external world either as doing or suffering, have been variously classified by psychologists, according to various principles: none of these, however, have a sufficiently wide basis in the dynamical laws of Life and Thought, of which the phenomena to be classed are the manifestations. Thus the instinctive feelings, passions, or propensities, have been simply set aside altogether in a class by themselves, and the remainder have been designated Emotions. These, again, have been divided into two groups, according to the corporeal phenomena which accompany them; namely, into active emotions (or "the passions" of some writers)—*i.e.*, the relative in action; and the passive emotions, or emotions proper—*i.e.*, the personal. In the latter, the heart, lungs, stomach, and intestinal canal, are predominantly affected; while in the passions, although these organs of vegetative life are implicated also, the *voluntary* muscles, or organs of external relations, are more markedly excited into great activity.

441. The extent to which the body shares in the feelings varies in different forms; hence the division of the feelings into the violent passions and emotions, and the gentle. Again, in some states of feeling the vital processes and organic functions are depressed, while in others they are excited beyond their natural equilibrium: hence another division into the exciting and the depressing. Again: The feelings have been divided according to the *intensity* of the feeling, or the *kind* of feeling; thus we have the pleasurable and the painful, and the like.

442. Finally, the feelings, faculties, and states of consciousness generally, have been arranged with reference to the objects aimed at and the ends attained by

the conjoined operations of bodily and mental changes (358, *sqq.*) This is the teleological principle which runs through all physiological research.* It is therefore necessarily the principle which must guide all classifications of mental phenomena in which this physiological *nexus* is recognised. Such is the principle of the psychological classification of phrenology, which is a system of mental philosophy that associates all the phenomena of consciousness with the functions of the cerebrum and cerebellum, as the seats and organs thereof.

443. In phrenological philosophy, such of the states of consciousness as denote a particular power of feeling, thinking, or perceiving, are identified with particular portions of the encephalon, which is termed the "organ" of the sentiment or faculty; the connection being determined by observation and inquiry, mainly of a physiognomical character (178). Those which are found to be fundamental, and thus connected with a special organ, or portion of the brain, are termed Primitive Faculties. Dr Spurzheim divided the mental faculties into two orders; the one he termed the *affective* (or orective), the other the *intellectual* (or cognitive)—in general phrase, the Feelings and the Intellect. The feelings he further divided into two genera, the Propensities and the Sentiments—*i.e.*, the instinctive and the emotional energies. This arrangement is adopted by Mr Combe, who remarks,—"He [Dr Spurzheim] applies the name *propensities* to indicate internal impulses, which invite only to certain actions; and *sentiments* to designate other feelings, not limited to inclination alone, but which have an emotion of a peculiar kind supperadded. Acquisitiveness, for example, is a mere impulse to acquire; veneration gives a tendency to worship, accompanied by a particular emo-

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* Vol. i. pp. 104–8.

tion, which latter quality is the reason of its being denominated a sentiment.*

444. While the arrangement of Dr Spurzheim is founded on a natural principle, it has this one merit above all others, that it attempts to take cognisance of that portion of the nervous system in man and the vertebrata which subserves to each of these various states of consciousness; and, starting from a fundamental principle essentially sound, it has arrived at a more complete classification than has hitherto been attained on purely metaphysical principles. And every one who has carefully considered this question, or has had to grapple with the difficulties which beset every attempt to arrange methodically those infinitely varying states of consciousness which constitute the sum of man's experience, must agree with the candidly expressed opinion of no incompetent or inexperienced judge:—"The phrenologists rightly represent the old classifications of mental phenomena (which are chiefly general expressions of function or capacity) as insufficient to denote the various propensities and specialties of thought, feeling, and action, observed in different individuals, manifestly original to a certain extent, and forming, in conjunction with certain acquired or modified habits, the particular characters of each."†

445. Before, however, a true classification of the various states of consciousness can be made, it is necessary to know the order of their development and their relation to each other. This knowledge can only be obtained when we have fully determined their causal relations, which, as we have amply seen, are correlative with the

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* *System of Phrenology*, 4th edit. vol. i. p. 180.

† Sir H. Holland, Bart. *Chapters on Mental Physiology*—"On Phrenology."

fundamental causes of vital sequence. Consequently a satisfactory classification is not possible if the law of evolution of mental phenomena from the general to the particular, correlatively with organismic evolution, be left out of consideration, the very basis of a sound superstructure being omitted. Hence we find not a few defects in the phrenological classification as to matters of fact. Thus "imitation" and "wit" (or mimetic representative action, and the sentiment of the ludicrous) are both placed among the superior sentiments; yet we know that both are amongst the primary instincts (394). Nothing is more amusing to the naturalist, than to watch the manifestation of the sense of the ludicrous in the instinct for practical jokes amongst young birds and mammals, as well as in the infant and adult man.

446. A proper classification of mental phenomena must therefore be based upon the same principles as a sound zoological classification. The forces of organisms are but the morphological manifestations of the same teleiotic ideas, which, when operating as causal ideas of encephalic nutrition and development, and so determining the form, size, and function of the organ (412), are evolved into correlative conscious states as intuitions or their derivatives. I shall therefore adopt this principle when I come to examine the physiological correlations of instinctive and vital processes; in the meanwhile, it will be necessary to determine the correlations of some of the fundamental beliefs out of which experience is confessedly evolved.

SECT. II.—*On the Origin and Nature of some of the Fundamental Beliefs.*

447. We have already established the fundamental

fact, that, in the widest sense of the term, consciousness itself is experience—is an experience of the vital changes in or by which we feel, think, and know (167). And thus we were enabled to show what is meant by "necessary" truth, and how the quality of necessity attaches to all our states of consciousness.* I need not, therefore, revert to this fundamental doctrine, as to what is experience and what belief. It is sufficient to re-state the doctrine, that, with reference to the acquisition of knowledge by experience, fundamental beliefs are fundamental intuitions which have the quality of necessity, as to being considered true in their relations. They are cognitive feelings in correlation with fundamental cognitions. Whatever may be the teleorganic changes of the encephalon, they are reflected in the consciousness as verities, since for the time being they have the character of necessity (172–175). But the majority of these changes take place with great rapidity, so that, however aberrant they may be, the change of one moment corrects the error of the preceding. When this corrigent sequence is interrupted, as in certain "electro-biological" states, or in insanity, then belief attaches to erroneous ideas. This necessity of belief has been well understood and acknowledged by metaphysicians, and is therefore no new doctrine; what I advance is, that the necessity is correlative with necessary teleorganic changes in the organ of consciousness. Brown maintains it: Reid also to the same effect observes, "We find it impossible to doubt a thing of which we are conscious. The constitution of our nature forces this belief upon us irresistibly."† All intuitions being correlative with vital processes, it follows that Belief, however certain, is in itself no proof whatever of the order of things external to the organism; it simply indicates the order of things internal—the character of the teleorganic changes, whatever may be their nature. It is only when these correspond in law of sequence to that of external phenomena that truth arises in the mind.

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* Vol. I. Part III. chap. vii. p. 287.

† *On the Intellectual Powers*, Essay VI. chap. vii.

448. Now, intuitions are only evolved into derivative truths by the operation of external impressions received through the senses from the classes of phenomena with which they are in affinity. Mere meditation can only evolve the relations of general or necessary truths; and this requires a well-balanced healthy organ. Hence, when from any cause an interruption to this play of affinitive external impressions on the intuitive substrata takes place, as from functional or structural disease of a portion of the brain, or from entire interruption of the access of external impressions, the teleorganic changes are no longer correlative with true belief. On the contrary, erroneous convictions of the most startling character take their place. This is well known to those who are familiar with the phenomena of insanity and delirium, in which the Belief in Existence itself is sometimes so modified that an individual so affected is firmly convinced that he is dead—nay, will undertake to superintend his own interment. To the non-professional class of inquirers, the best illustration, however, is afforded by the condition of the consciousness known as dreaming, and which few men have not experienced. In these, the senses being shut by sleep, there is no admission of external impressions, and therefore no perception of the external world; consequently, there is no cognition of the relations of the individual in Time and Space. As the immediate result of this state of things, the law of Relativity is interrupted in its most important element; and thus no conclusions in dreams, as to the

relations of the individual to time and space, are too incongruous for belief. Years pass in a moment; space is traversed instantaneously, and without effort; the dead appear again, and enter familiarly into the business of life; yet the dreamer does not perceive any incongruity in the notions or actions dreamt.*

449. Dreams are the exact analogies of insane delusions; so that dreaming is a temporary state of insanity. Dreams, too, are the types of ordinary errors as to the nature and relations of things; for whenever man neglects to observe the order of phenomena in Time and Space, substituting therefor the fleeting presentations to his mind of the unregulated vital forces, which meditation in a weak badly-constructed brain develops, error necessarily arises. Truth is only attained when these presentations correlate the order of phenomena in nature; and the vital forces can only act so as to develop true teleiotic ideas when the sequences of change which they induce are developed and regulated by true sequences acting from without. This is the law of all scientific inquiry, and therefore the basis of all methods by which the understanding is properly exercised about things. When it is broken by or from any cause, error is inevitable.

450. A belief in our *personal identity* is among the fundamental beliefs of our nature. This is a conviction or certainty that we are at this present moment the same person that we were the moment before, and before that; and so on, as far back as we can recollect. This belief correlates the fundamental teleiotic idea of the permanence of the One (218), of which the subordinate ideas are the ideas of the Present, Past, and Future.

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* See, for illustrations, my essay "On Sleep, Dreaming, and Insanity," *Jour. of Psych. Med.*, Oct. 1851.

451. But the teleiotic idea of the future correlates also the belief in our *continued* existence, in virtue of which "all men think men mortal but themselves." This is the intuition of the teleiotic idea of inevitable and continuous succession in time and space (217). "Why is it," Dr Brown remarks, "that we believe in that continual similarity of the future to the past, which constitutes, or at least is implied in, our notion of power? . . . It is not to experience alone that we must have recourse for the origin of the belief, but to some other principle which converts the simple facts of experience into a general expectation or confidence that is afterwards to be physically the judge of all our plans and actions. This principle, since it cannot be derived from experience itself, which relates only to the past, must be an original principle of our nature. There is a tendency in the very constitution of the mind from which the expectation arises—a tendency that, in everything which it adds to the mere facts of experience, may truly be termed instinctive; for though that term is commonly supposed to imply something peculiarly mysterious, there is no more *real* mystery in it than in any of the simplest successions of thought, which are all, in like manner, the results of a *natural tendency of the mind to exist* in certain states, after existing in certain other states." *

452. This intuition of continuous and necessary succession, carries with it the intuitions of both past and future existence. It is therefore in correlation with the teleorganic changes in the encephalon as a whole, and with all those states of consciousness, whatever they may be, which have regard to the past or the future.

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* *Lectures on the Philosophy of the Human Mind*, vol. i. pp. 121–2. Compare also p. 286 for an equally if not more instructive exposition of intuitive beliefs.

These are, especially, the pleasures and pains of memory, imagination, hope, and fear. (386, *sqq.*) It is well known that this belief may be deeply modified by both healthy and morbid states of the encephalon; under well-known conditions—as profound sleep, the action of narcotics, cerebral compression, and the like—it is wholly abolished. But there are morbid states, not at all uncommon, in which there is a double consciousness; that is, two series of dissimilar mental states, alternating with each other, in which the thoughts and character are so different, that the man has a double personal identity, and acts like two individuals—nay, cannot remember in any degree in the one state what occurred in the other. This is due to alternate separate action of the two halves of the *cerebrum.**

453. The normal personal identity may be wholly set aside by erroneous beliefs, originating in morbid or even healthy states of the brain. Every large asylum has within its walls individuals who have a firm conviction that they are other persons than they really are. Reigning emperors, kings, and queens abound: not a few consider themselves to be the most exalted of beings, as God, Christ, the Holy Ghost. What occurs in the insane as a permanent chronic condition of the brain, often occurs in delirious states, dreaming, intoxications. In these our consciousness, beliefs, feelings, and personal identity, undergo the strangest transformations, all in correspondence with the irregular trains of teleorganic changes going on in the cerebrum. Checked by no corrigent stimuli derived through the senses—or, in other words, by no conscious states derived from the external world, or not verified as to their truth by the normal processes

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* Sir H. Holland. *Chapters in Mental Physiology*—"On the Brain as a Double Organ."

of verification—they reach the consciousness, such as they are, with all the force of true intuitions. A more healthy cerebrum, or a return to normal action, can only modify the beliefs thus induced.

454. *Belief in the Exercise of Power.*—With every series of ideagenic and kinetic changes that end in *action* upon the external world, there arises in the consciousness the intuitive feeling of the exercise of Power. This feeling is very strongly developed in acts not willed, such as the instinctive actions of combativeness and destructiveness, in which power is strongly exercised. Now, this feeling is correlative with the intuitive idea of Power, as it is also of *Cause;* for, concurrently with the feeling of *exercise* of power, there is another—namely, that the *individual* himself, the *Ego*, exercises it. This fundamental belief in the exercise of power is an intuition corresponding to that teleiotic idea which directs and uses the molecular forces so as to control the physical forces (101), that the great ends aimed at according to the law of adaptation may be attained. It is an act of energy, without which all thought, whether pure or concrete, must remain Thought. The belief, therefore, in the exercise of power is correlative with the teleorganic changes upon which the development of active force depends.

455. This belief in, and the exercise of power, with the corresponding intuitions, is at the very root of man's moral beliefs, and links him with the Divine. Thus Reid remarks, "I believe we get the first conception of power, in the proper sense, from the consciousness of our own exertions; and as all our power is excited by will, we cannot form a conception how power can be exerted without will. Hence the only notion we can form of Almighty Power is, That He can do what He wills."

456. The *belief in Cause* is correlative with this belief in the exercise of power. As change is the result of force, no change is presented to the mind without the intuitive belief that it has been caused—*i.e.*, that some other thing, as an efficient agent, preceded it in time (150.)

457. The *belief in Design* in the Exercise of Power.—Every act ending in the transference of force is associated with the fundamental intuition of an end aimed at; while the coincident action to a definite end implies the idea of action to an end designed or anticipated. Now this is the fundamental belief in design, the fundamental idea of reason, and the most elementary truth of the understanding (133). It is hardly necessary to remark that it correlates the fundamental idea of creation—the coincidence of all processes and events to definite and anticipated ends (130). It is by this fundamental belief that man is compelled to recognise Mind in phenomena (p. 108); while the correlative intuition is that which, in its concrete form as a causal idea, is his grand and special prerogative as a rational being.

458. The *belief in Power over the Thoughts.*—There is a sensorial will and a motorial will. By the latter we control things external to ourselves; by the former, we control the internal or teleorganic changes which correspond to states of consciousness. Now, as the teleiotic idea of design is the fundamental idea of both, we have a corresponding belief that we guide the immediate order of teleorganic events. But this is not so; it is only over the occasions of our trains of thought that we exercise control (32); the successions, whatever they may be, correlate vital successions—and these, our necessary intuitions and beliefs. So that we can only regulate the trains of our thoughts by knowing beforehand what will

develop them. Some recent writers on physiological psychology have founded their theories of cerebral function on the untenable hypothesis, that we can exercise an immediate or direct control over the vital sequences going on in the encephalic tissue, which hypothesis is founded upon this belief.

CHAPTER VII.

THE EVOLUTION OF THE INSTINCTS, FACULTIES, AND FEELINGS, AS EXPERIENCE.

SECT. I.—*Evolution of Doubt, and of the Desire to Know.*

459. THE evolution of a fundamental idea or intuition is a continual differentiation or dichotomisation. Now, in all vital processes, and in all the states of consciousness which correlate them, this continual evolution and subdivision into the Manifold is a continual departure from the Absolute; so that, in proportion as the particular is reached, in that proportion the ideas are contingent, relative, and doubtful; in proportion as the results of experience are general, in the same proportion they are not doubtful, and are believed in (vol. i. p. 96). In Mental Dynamics, doubt is the correlative of belief; and since absolute belief, as intuition, belongs to all our notions of the unchangeable, universal, and general, so doubt belongs to our notions of the varying, contingent, and particular. Hence it follows that, by the operation of the same law in virtue of which man has fundamental beliefs, he must also experience continual doubt. There can be no belief, therefore, in the deductions of experience without an antecedent doubt.

460. This state of consciousness correlates other teleiotic ideas, but more especially those of incessant change, imperfection, and incompleteness (306). Doubt arises, therefore, when the teleorganic changes going on

in the ideagenic substrata are minutely differentiated, and do not end in definiteness and completeness; and consequently, doubtful notions, or feelings of doubt, are correlative with indeterminate and indefinite vital sequences. As a result of this law, two other states of consciousness arise—namely, a desire to know definitely, or have clear notions, and a desire to fulfil that desire, *i.e.* to verify or make certain the incomplete cognitions. Each of these desires corresponds to a fundamental energy or faculty of cognition and volition.

461. The teleiotic origin of doubt, and its consecutive or derivative energies, is shown by the phenomena of instinct in lower animals, and the first strivings after knowledge of infants and young children. In these, at first, and in the greater number of organisms endowed simply with consciousness—perhaps even in those with a higher evolution of the faculties—there is no doubt, because there is no conscient reception of any other than the affinitive impressions which excite the appetites and primary instincts. These are received mainly through one sense acting singly—as through the olfactory sense for food, the gustatory sense as to what is alimentarily good or evil, and the like. The feelings excited are simply sensations of the qualities of matter—as bitter, sweet, sour, nauseous, hard, soft, smooth—or the simplest impressions of colour and form. There is no pause to analyse the source or cause of the feelings, and consequently no time enters into the states of consciousness thus induced. The result follows instantly as a complete result, upon receipt of the affinitive impressions; so that the whole series of phenomena—that is to say, the reception of the impression by the recipient apparatus, the sensation which follows the desire to energize, and, finally, the consequent actions—are, or appear to be, simultaneous.

In other words, no thought intervenes between the reception of the excitant force, and its termination in animal motions.

462. *Desire to Know or Feel.*—The process is different, however, when the impressions received are too slight to act upon the organism so as to end at once in motion, yet, nevertheless, modify the consciousness. The feeling thus induced is often one of vague indifference; that is to say, the pain or pleasure is small, while as to the mental state it is not so much indifferent as indeterminate. It is a condition of doubt, suspense, or uncertainty, correlating the indefinite character of the teleorganic changes induced by the affinitive impression. Thus a feeling of doubt or uncertainty arises as to whether the external circumstances represented by the vague indefinite impressions are injurious or beneficial, pleasurable or painful, congruous or incongruous with preceding states. The state of consciousness corresponds, and therewith arises a desire to end this uncertain state—*i.e.*, to *know* or *feel* their true nature. This is the fundamental desire of those mental processes termed the Thoughts, and of the higher Feelings or Sentiments, into which time enters as an element, and which have reference to the seeking after what is beneficial, or avoiding what is injurious; or to the determining of what is congruous and incongruous. It is that fundamental element of the Knowing faculties which has been termed *curiosity*, and which has its most marked manifestation in childhood, when all mental impressions are vague and indeterminate.

463. The credulity of childhood must not, however, be looked upon as antagonistic to doubt. It is ignorance, and arises because the encephalic tissue is as yet but little differentiated, and consequently communicated notions easily become definite; or, in other words, there

is no room for doubt, because there is no occasion for indefinite impressions from that source. So soon as they become indefinite, then the child begins to question—his curiosity and his doubt are developed. Credulity is thus quite compatible with the marked inquisitiveness of childhood.

464. The combined operation of credulity and curiosity, in connection with the stimulus of the desire to know, is manifested in a great variety of errors, both social and individual. It is the basis of the mystical in experience and scientific research; and it is often manifested in various forms of insanity, and in what may be termed epidemical aberrations from common sense.*

465. *Experience of Time.*—It is a condition of all thought and mental action that it occupy time. Now, between the indeterminate cognition resulting from an indeterminate impression, and the change into a determinate cognition or clear conception, a series of mental processes and teleorganic changes intervene, of which the teleiotic idea and intuition of successional sequences in time and space are essential elements. It is therefore into this group of instinctive faculties and states of consciousness that the intuition of time first enters as an element of mental existence. In the minute, highly derivative changes which constitute vital processes, there is no consciousness of them whatever; when consciousness is evolved, the feeling of incidence of the affinitive impression, and the correlative actions, appear to be simultaneous; but when the derivative and contingent become objects of consciousness, thought begins. Hence the intuition of time is a necessary con-

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* For illustrations, compare my essay "On the Psychology of Monomaniacal Societies and Literature," *Journal of Psych. Medicine and Mental Pathology*, July 1854.

dition of the intuitions of all contingent vital phenomena; of all temporary adaptations to ends; of all those processes by which the substrata of memory are developed; and, most important of all, of those successional processes which correlate the successions of our thoughts and the intuition of continued existence or personal identity (21). Without it there is no cognition of mental life.

466. The desire to feel definitely, and to know, is a fundamental element of human nature. It is the primary source of all philosophy and all science. It incites to the acquisition of knowledge for two ends: *first*, Because it is a great happiness to gratify the desire when knowledge is sought as philosophy (vol. i. p. 13, *sqq*.); *second*, Because the desire is combined with another desire to attain some future good, or avoid some future evil. In this case the desire to know is prescient in its character, and includes the intuitions of time. (359, *sqq*.)

467. The desire to know definitely and presciently is also one of the most urgent of the instincts proper of man; it leads him on to the most mystical speculations as to the future, and is the orectic basis of all the arts of divination, as well as of scientific Prolceptics or anticipation of the order of nature. It is often manifested in various forms of insanity, and in all forms of mysticism.*

SECT. II.—*Evolution of the Faculties of Experience.*

468. In man and the higher animals, the period of doubt being that occupied by the thoughts and by the

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* For illustrations of the pathological developments of this desire to know presciently, and of its social influences, compare my essay "On Modern Demonology and Divination," *Jour. of Psychol. Medicine*, January 1854.

operations of all the faculties by which knowledge is acquired, the latter are correlative with the contingent Instinctive Faculties in lower animals, and may be termed *psychal instincts*. Their instinctive character has been already proved empirically. (73, *sqq.*) We shall now see how it is that this resemblance between the instincts proper and the intellectual faculties could not fail to be noticed, and how the former should manifest so much of prescience as to resemble reason (370).

469. *Sensational Verification.*—The faculty common to all is that which correlates the desire to know definitely, or *Verification*. In the lower animals, one sense is usually entrusted with the duty of verifying an indeterminate impression. This is the organ of touch developed into antennæ or other tactile organs. Thus the mollusks, as snails, slugs, &c., may be observed to stop and carefully examine an object from which they receive an indeterminate impression. This process is sensational verification in its simplest form.

470. Verification is, however, more complex in animals with multitudinous external relations; for the numerous impressions they receive are intensified and regulated by special organs adapted to receive them, to the end that they shall not be indeterminate. In these the impressions of reflected light from objects are intensified and regulated in a highly developed organ of touch—the eye—expressly adapted to receive the undulatory impulses of light. The atmospheric undulations, and the vibrations which cause the sensation termed Sound, are in like manner intensified and regulated by an acoustic multiplier—an organ of touch acting upon another nerve of touch, the auditory nerve. The odorous particles held in solution in, or mixed with, the atmosphere, are received upon another apparatus with its corresponding nerve

arranged for the express purpose upon those passages (the nostrils) through which the air must necessarily pass, in the act of breathing, before it enters the lungs. In like manner the tactile apparatus on the tongue, fingers, and toes, is in connection with a muscular apparatus, whereby the impressions of resistance, extent, and other qualities of matter, may be intensified. Thus, every sense has its own proper motor apparatus—its multipliers, intensifiers, regulators, exquisitely adapted to the purpose aimed at. It is these that are brought into action in an act of sensational verification. Corresponding to each of the recipient nerves there is an appropriate nerve-centre, in which teleorganic changes are coincidently excited; and thus sensible images, sensations, and perceptions of the qualities of matter, arise in the consciousness.

471. But however exquisitely adapted to multitudinous impressions, so as to avoid all sources of failure, the organs of sense may be, yet, when acting singly, they may and do receive insufficient, erroneous, or doubtful impressions, which, if not corrected, would finally excite inappropriate changes in the substratum of thought; and thus disorder and indefiniteness of ideas would arise. To obviate this source of error and doubt, the special senses are *combined* into a common action upon a common object of sense by a co-ordination of their nerve-centres; and to this end a special ganglionic structure is formed, so that the impression received by one sense is compared with that received by the others, and thus a verification of the impressions is attained.

472. *Instinctive Attention.*—Now this entire process has usually been termed *attention* by metaphysicians and physiologists. It is obvious, however, that we must distinguish between the vital process whereby the recipient organs and the encephalic structures have their functional

activity intensified, and that which follows thereupon. The latter is comparison (378), the former is attention, properly so called. As an element in the process of verification, it has obviously an important physiological bearing upon the functional activity both of the organs of sense and of the encephalic structures, in all mental acts (400).

473. Physiologically, attention consists of two processes, each distinct, yet mutually dependent. *First*, The *organs* of special sense by which the vague impressions are received, are put into such a vital condition that the influence of the impressions upon the recipient nerves is intensified—*i.e.*, the mechanism becomes more adapted to the action of the forces. This occurs when we *try* to smell, to taste, to hear, to feel by touch more distinctly: since this part of the process results specially in a change in the recipient mechanism through the apparatus of muscles connected with each, it is essentially an act of motor volition. *Secondly*, The nerves by which the impressions are received, and the corresponding ganglia to which they are conveyed, are at the same time so modified in function, that they also become more susceptible of the influence of the impressions thus more determinately received in consequence of the volitional act. Now, this is a temporary hyperæsthetic condition; and as I shall show that such conditions are due to increased vascular activity in the nerve-centres, this process resolves itself also into a motor act, directed to the blood-vessels.

474. *Comparison as Mental Attention.*—Sensational comparison follows upon an act of attention, and is essential to verification; for without that there can be no notion formed of congruity or incongruity—similarity or dissimilarity, and thus the desire to know the true relations of things to the organism be gratified (462). But when

this series of processes goes on in reference to trains of thoughts in which abstract ideas and notions are indefinite and indeterminate, the process is much more complex. Here, again, the whole series of changes has received the name of attention—or more specifically, mental attention. The difference between it and sensational attention is mainly as to the portion of the encephalic tissue, which is the seat of the coincident vital changes. In mental attention, there is little or no intensification of function of the organs of sense, or their ganglionic centres. The faculty is busy with abstract cognitions, and the intensification of functional activity is limited to the organs of the higher powers—the cerebral hemispheres, or portions of them. It is, however, of the same character as regards its physiological results; that is to say, an increased vascular activity in the encephalic tissue is coincident with the process.

475. The verification of the observations and conclusions of experience is Science. Without such verification experience is often erroneous, and leads to error in thought and act. Modern science is distinguished from the ancient by the numerous aids to the senses it has invented, with the object of intensifying, regulating, and correcting the impressions derived from external things. Hence our highest faculties are the differentiation of a primordial instinct. This law of verification is, in fact, a universal law; it is seen not only in science, but in all the proceedings by which mankind seek to attain definite knowledge with a view to practical ends.*

476. The *representative faculty*, when developed in experience, is mainly manifested in the arts or in writing. It is therefore essentially an act of volition. If a notion be not clearly conceived, it is not clearly expressed,

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* Compare "Dissertation on Method," vol. i. pp. 96, 97.

whatever may be the method taken to express it. But even when clearly conceived, the changes in the kinetic substrata, which correlate muscular action, do not always follow the impulses of the ideagenic substrata. Hence, although a man may form what appears to him a complete ideal, he cannot realise it, except after repeated trials. By this means a motor habit is at last formed, and the muscles act with the same promptitude as in reflex acts. It is in this way that experience is necessary to artistic skill. Nor must it be forgotten that a training of the hand, or eye, or ear, is not all that is needed; the encephalic tissue must itself be developed, or otherwise there is no acquisition of knowledge for practical ends—*i.e.*, of experience in art.*

477. *Pleasure* and *pain* are associated more or less with all these faculties and processes of experience. Fundamentally, these arise when the state of doubt ceases, and the desire to know is satisfied—or, in other words, the

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* "A printer accustomed to set type never thinks what the letters are which he is to put into his stick. He never looks at one of them as they go in. But when he first began to set type, it was a very different thing with him. He looked and read. 'And as they departed thence,' &c., and so began—'And,' *a*; and then he had to see which end was up! He puts in *a*, and comes to *n*. He takes up the wrong letter! He puts that back, and gets the right one in. Then he gets *d*, and puts that in. Then he thinks, now there is a space wanted, and he divides one word from the next one. Then comes the next word, and he looks at each letter, and makes mistakes at that. But go a year after, and let the man set up the same verse, 'And as they departed thence, Jesus began to say to the multitude'—he reads as much as that, and then clink! clink! clink!—it is all done. What made that? How those different faculties of mind—the muscles—all work! What an immense amount of trial and discipline has been condensed into that automatic power! This is a wonderful element of human mind!"—H. W. BEECHER.

teleorganic changes are duly completed. But the same laws of action apply equally to volition as to cognition; so that if once a series of teleorganic changes is begun, the desire to end it, or complete the succession, persists until it is completed. In this way it happens that muscular activity is such a relief in many cases of disturbance of the feelings; thus, too, we understand how it is that "revenge is sweet," and how a man, when once offended, is with difficulty reconciled to another, until the offence is condoned, or Nemesis satisfied. The same law is operative in all the æsthetic acts and feelings. If an idea haunts the mind, there is no "laying" it until it be completed by representation. The best illustration of this law is to be found in the influence of rythmical ideas (as in habits of drumming on the table, &c.), which, by their very nature, require to be completed by a measured series of successional changes.* Numerous other states could however be adduced, both healthy and morbid, as illustrative of the general law of experience, that to attain to certainty and pleasure in experience, the teleorganic changes once begun by affinitive impressions must not be left imperfect and unfinished, but must complete the cycle of change, and the transeunt force be expended either in the ideagenic or kinetic substrata, or in both.

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* The following is one of many illustrations that might be given:—"Dined with Power to meet Bishop. . . . He mentioned a good story to prove how a musical ear requires the extreme seventh to be resolved. Sebastian Bach one morning, getting out of bed for some purpose, ran his fingers over the keys of the piano as he passed; but when he returned to bed found he could not sleep. It was in vain he tossed and turned about. At last he remembered that the last chord he struck was that of the seventh: he got up again, resolved it, and then went to bed and slept as comfortably as he could desire."—*Memoirs of Thomas Moore—Diary*, vol. ii. p. 341.

478. Although the instinctive character of the faculties of experience has thus been fully established, it may not be useless to illustrate it further by pathological phenomena. The best illustrations of this kind are afforded by the phenomena of sleep and somnambulism, and by those manifested under the influence of alcohol, opium, chloroform, hachisch, and other nervine irritants and anæsthetics. During the waking conscious state, all the external senses instinctively co-operate in verification without the knowledge of the individual, and so place him in fitting relation with the external world (470). When they cease to transmit impressions unitedly, from changes in the co-ordinating sensory ganglia, unconsciousness begins to approach; and when the senses are at last shut up, so that no affinitive impressions reach the ideagenic tissue, sensation, perception, and thought cease; and all verification end. If, however, the impressions reach the tissue, and are not co-ordinated, then false thoughts will arise; for while there is no correct knowledge of the external world, the impressions themselves excite ideagenic changes. These result either in somnambulistic or delirious acts and thoughts. Chloroform sometimes develops this state of somnambulistic activity, and the world of dreaming becomes a world of reality to the individual. Erotic dreams are sometimes thus excited in women, which have led the dreamer to make a charge of rape.*

479. In the application of these doctrines to pathology—*i.e.*, in examining the operation of the faculties

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* An instance of this kind occurred lately in the United States: a dentist was tried and unjustly convicted on the evidence of a young woman, as to an alleged rape committed on her, which she dreamt took place while under the influence of chloroform, he having administered it to her in the exercise of his art.

in morbid states of the encephalon, as in insanity—it is absolutely necessary to bear in mind the exact order of the processes, since they appear separately as diseased states, and often in succession at intervals. Thus a tendency to spectral illusions is premonitory of insanity or active delusions; imperfect co-ordination of the senses may be followed by a failure in comparison, and the judgment thus be insanely perverted, since the congruity and incongruity of thoughts and actions cannot be determined (474).

SECT. III.—*Evolution of the Egotistic Faculties and Feelings.*

480. The great object of the law of design being the continuance of the organism in time and space, the intuition of doubt and the desire to know the relations of external things to the organism are correlative with that end. Hence all the faculties of experience are primarily modes of organismic energy, whereby the alimentation, protection, and healthy existence of the individual are secured. They are the Self-seeking, or Egotistic Faculties.

481. Now, in lower animals these egotistic faculties occupy the period of doubt and indefiniteness, as Instincts of Defence. The organism would be left defenceless unless a provision were made for its protection during the period of suspended action. Hence it is, that a series of instinctive modes of energy, or instincts proper, with their correlative desires and feelings, are developed, which are specially adapted to the needs of the moment; or, in other words, to the contingencies that may happen to the individual within that period. These egotistic faculties, therefore, are contingent

faculties, with their contingent functions, desires, and feelings.

482. Contingent *desires* are manifested in various ways. They constitute a group in relation to, and springing out of, the primordial conception of Prescience, or foreseeing of the Desirable or Undesirable (364), and vary in organisms according to the contingencies to be provided for. These variations constitute special modifications of the instinct of self-defence and well-being, of a peculiar character, which thus become the leading or principal characteristics of species, classes, and races. Thus, animals are characteristically curious, cautious, timid, cunning, watchful, and the like, according to their modes of existence and the methods of self-defence appropriate thereto. It will suffice to examine the correlations of a few of these instincts and instinctive feelings.

483. *Fundamental Conservation of the Organism and of the Orderly Sequence of Vital Processes.*—The contingency of doubtful results, from the influence of alimentary and other *ingesta*, is provided for in the adapted succession of the vital processes themselves, which are so arranged that organs (the excreting viscera) are constructed expressly for the removal of what would be hurtful if retained in the blood or the tissues. There is an anticipation of evil results, as indicated by the provision against them (306). When disorder actually arises in the order of vital changes from the presence of injurious agents, a series of what may be termed defensive vital processes are developed, the cause of which has been designated the *vis medicatrix naturæ;* it is, however, only another form of the *lex nostri conservatio.*

484. When we ascend higher, and examine the instincts by which the body generally is defended from injurious agencies, we find the same law in operation.

Instruments of offence and defence are formed just as eliminating viscera are formed, and these are exercised as automatically and unconsciously as the functions of the viscera (343). But they are only put in operation consecutively to the reception of affinitive impressions by the sentinel-organs—the senses; so that if these do not reach the organism, no action results. If, however, they are indeterminate, then doubt or curiosity is developed.

485. *Instinctive Curiosity.*—Each animal having its own sphere of life, with the conditions proper to that sphere, and with the instincts adapted to those conditions, if new conditions be introduced there must be new adaptations, either temporary or permanent, accordingly as the new conditions are temporary or permanent. But these new conditions may have no effect in the sentinel structures, and the first experience of their agency may consist in the injury they have inflicted. In this way animals unaccustomed to man are at first easily shot, trapped, or poisoned; it is only after repeated suffering that at last defensive adaptation is put in force. This ignorance, as it is termed (463), arises from the indeterminate character of the impressions received. They excite no pleasure or pain, otherwise than a pleasant feeling of curiosity or surprise at the novelty of the impressions. In this state there is instinctive comparison, and from the feeling of difference arises the emotion of surprise and the instinct to inquire. It is one of the earliest-developed instincts in man, is especially seen in uncivilised races, and is very common in mammals and birds amongst vertebrates.

486. *Caution.*—In many animals, however, there is a precautionary adaptation against contingent personal injury from unknown sources. When an indeterminate

impression is received, an instinctive act or series of acts is performed, so that it may be more determinate; and until that is done, the animal suspends further action. This is the instinct of caution. As a teleiotic process, it is manifested very extensively throughout creation, both in the animal and vegetable kingdoms. A touch of the leaf of the *Mimosa sensitiva* does that leaf no injury; yet it closes protectively. A touch of the tentacles of a snail is harmless to the animal; yet, if it be sufficiently firm, the snail will immediately retreat within its protective shell. The ordinary inhabitants of a marine vivarium, as the hermit-crabs, whelks, actiniæ, exhibit the same kind of precautionary instinct. In higher animals it is the sentiment of caution or prudence, and is associated with the feelings of timidity, fear, suspicion, terror, in man and mammals generally. Caution and cunning are the predominant instincts of unarmed animals, and of those animals generally that are not combative. They are also associated closely with the reproductive instincts. In man, caution is an important element in prudence and foresight, and is often combined with a high order of intellect.

487. *The Sentiments.*—In man, there are a variety of sentiments and higher feelings which are primarily contingent, but have their root so deeply in the fundamental instincts, that their true character is hardly recognised. Of this kind are the vague sexual feelings which arise during puberty, and which give rise to modesty, bashfulness, unconscious sexual sympathy, or love, and the like. The instinct of defence is in this way also the source of the sentiments of hatred, revenge, antipathy.

488. It would not be possible to discuss, in brief compass, this large class of feelings of experience. They

belong to memory. Perhaps it may suffice to say, that pleasure and pain are intimately associated with all the contingent changes upon which memory depends. Life-long antipathies and sympathies are thus associated with the operation of the faculties of experience. It is co-incidently with these that ideagenic and kinetic sub-strata are most permanently, even indelibly established, ready to be excited whenever the correlative changes are induced (394). Deadly feuds between a "fag" and his "fagger" have thus been excited, which have continued through life.* In the insane, sometimes intense hatred is thus developed toward those of their friends or relations who have offended them in the earlier stage of the disease by exercising control over them. Locke refers to this class of phenomena with a view to show that "Ideas [of experience] in our mind, when they are there, *will* operate according to their nature and circumstances."

489. All the class of egotistic sentiments and instincts of the contingent kind are developed in insanity, and give names to the various forms. They may be grouped, however, in two great classes, according as they are

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* Hartley Coleridge was a dwarfish, peculiar boy, without physical energy. He suffered when at school the puerile annoyances consequent upon these characteristics; and being also peculiarly constituted as to his nervous organisation, these annoyances seem to have left indelible substrata therein. In a letter to his mother, when thirty-five years old, he writes: "Strange it may be, but I have an instinctive horror of big boys; perhaps derived from the persecution I suffered from them when a little one. When I am at all unwell, . . . they are always at me in my dreams—hooting, pelting, spitting at me; stopping my way, setting all sorts of hideous scornful faces at me, oppressing me with indescribable horrors, to which waking life has no parallel."—*Poems of Hartley Coleridge*, edited by his Brother; *Memoir*, vol. i. p. xcviii.

associated with the suspicious, timid, doubting, or the confident, bold, and positive. In the one class we can include all the well-marked forms of melancholia; in the other, all those manias of pride, ambition, and self-esteem, which so often precede or accompany the so-called general paralysis of the insane.

CHAPTER VIII.

ON FUNDAMENTAL INTUITIONS AS SCIENTIFIC IDEAS, OR CAUSAL IDEAS OF THE SCIENCES.

490. Since each primary intuition, considered as a causal idea, carries with it a long series of derivative ideas, evolved through, or on the occasion of, experience of the external world, it is possible to fix upon those primary intuitions which, as fundamental scientific ideas, constitute the root of all the derivative ideas of which the sciences are made up. I propose to examine some of these intuitions as the causal ideas of Sciences, both abstract and applied.

491. *Fundamental Intuitions.*—We have seen how these ideas, acting as evolutional energies, develop the cognitive faculties, and their correlative substrata. It is these faculties which are employed in all scientific culture; but since none acts singly, it will be useful to indicate those primary intuitions which enter into combined action, when the acquisition of knowledge is the business of the man. The simplest mode of indicating this unity of action will be to show that the results of the operation of these faculties, as teleiotic energies, are the same as have been set forth by the logician and metaphysician; for this purpose the doctrine of one of the most distinguished of living metaphysicians, deduced empirically, may be noted as is in accordance with this doctrine established scientifically.

492. Mr J. S. Mill observes:—"Existence, Co-existence, Sequence, Causation, Resemblance, one or other of these is asserted or denied in every proposition without exception. This fivefold division is an exhaustive classification of matters-of-fact; of all things that can be believed or tendered for belief; of all questions that can be propounded, and all answers that can be returned to them. Instead of Co-existence we shall sometimes say Order in Place, and Order in Time."* These fivefold matters-of-fact correspond to intuitions or cognitions and intuitive Energies; thus—

1. Existence	=	Unity in Space	=	Consciousness of being One.
2. Co-existence	=	Duality in Time and Space	=	Self-consciousness, or consciousness of the *me* and *not-me*.
3. Sequence	=	Co-existence in Time . .	=	Intuition of Change.
4. Causation	=	Design + Force, or the Cause of Existence, Co-existence, and Sequences	=	Intuition of Cause.
5. Resemblance	=	Relativity	=	Synthesis of the One and One—Comparison, Apperception.

493. If we consider the latter mode of cognition as unity, in its most general form and including all derivative modes, it corresponds to the fundamental faculty of the understanding, or—as unity acting causally (the "immaterial *Ego*")—is the understanding itself. "The thought I have," says Kant, "that these representations, given in intuition, belong all of them to me, is just the same as 'I unite them in one self-consciousness, or, at least, can unite them;' and although this thought is not itself the consciousness of the synthesis of representation, it presupposes the possibility of it; that is to say, for the reason alone that I can comprehend the variety of my representations in one consciousness, as I call them 'my representations;' for otherwise, I must

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* *System of Logic*, 4th edit. vol. i. p. 115.

have as many-coloured and various a self as are the representations of which I am conscious. Synthetical unity of the manifold in intuitions, as given *à priori*, is therefore the foundation of the identity of apperception itself, which antecedes, *à priori*, all determinate thought. . . . This principle is the highest in all human cognition."*

494. If we had as clear conceptions of things as we have of this act of synthetical unity, the understanding itself would be intuitive as to all its conceptions; but our understanding can only use the fundamental ideas and intuitions as elements of thought, and must look without, *i.e.* to experience, for the exciting cause of its conceptions: without these there can be no development of the teleorganic processes, and therefore no ideagenic succession. And under each form are special experiences and sciences, each with their own predominant intuition or group of intuitions, as a basis of evolution of ideas. Now the special experiences are also termed ARTS, while the sciences are THE SCIENCES proper; of which we have marked out three great divisions (p. 88). I will give a rapid notice of some of the fundamental intuitions, and their correlative Sciences and Arts.

495. The intuition of *Existence* in time is as fundamental as the intuition of unity. Its fundamental derivative ideas are the intuitions of the Past, the Present, and the To-come or Future. These are causal ideas throughout the entire series of phenomena of life and thought, and are in fact correlative with unity, or the One as existing in time. This intuition and its derivatives, Cause, Matter, Force, are the fundamental ideas of all the sciences of matter and life, grouped under the

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* *Kritik der R. Vernunft*—"Deduction of the Conception of the Understanding," Lecture ii. sect. 12.

general terms Physics and Biology, including Palæontology (202). They are the elementary principles of all the systems of philosophy that have ever appeared, whether ancient or modern (113. Summary).

496. *Intuitions of Number, Time, and Space.*—Number is necessarily a derivative of the idea of unity, which is the primary idea of all ideas of number, they being all derivatives of One (167). The secundo-primary ideas are those of the Dual and Plural. The ideas of number are wholly conditional, however, like unity itself, upon the ideas of time and space, which they mark; for we can only cognise a thing as existing in time and space (380). Time and Space and Unity, or the One, being necessary conditions of existence (281), the fundamental intuitions of them necessarily enter into our cognitions of things external to ourselves; consequently they are the fundamental ideas of all science of phenomena.

497. It is usual, however, to limit these ideas to the pure sciences. Thus Dr Whewell observes, "All external objects and events which we can contemplate are viewed as having relations of Space, Time, and Number; and are subject to the general conditions which these ideas impose, as well as to the particular laws which belong to each class of objects and occurrences. The special laws of nature, considered under the various aspects which constitute the different sciences, are obtained by a mixed reference to experience and to the fundamental ideas of each science. But besides the sciences thus formed by the aid of special experience, the conditions which flow from those more comprehensive ideas first mentioned, Space, Time, Number, constitute a body of science applicable to objects and changes of all kinds, and deduced without recurrence being had to any observation in particular. These sciences, thus unfolded out of ideas alone, un-

mixed with any reference to the phenomena of matter, are hence termed *Pure* Sciences. The principal sciences of this class are Geometry, Theoretical Arithmetic, and Algebra, considered in its most general sense as the investigations of the relations of Space and Number by means of general symbols."*

498. The ideas of Space, Time, and Number, constitute also the basis of those sciences which deal with the motions of bodies. In this group the fundamental intuition of Change as *motion*, without reference to the forces, is an essential causal element. The fundamental science is "Pure Mechanics,"† and the derivative sciences are those of "Mechanics proper," or the sciences which treat of machinery. The correlative Arts are evolved in experience by the use of the muscular system, which, taken in connection with the bones, is a system of machinery evolved according to the principles of applied mechanics, developed in the lever, wheel, axle, wedge, &c. The derivative intuitions of experience are applied instinctively by organisms through this system to the purposes for which mechanics proper are applied.‡ Formal astronomy is a branch of pure mechanics.

499. The intuitions of *cause* and *force* in synthesis correlate the intuitions of change in space and time. Now, this change in bodies is manifested by changes within our organisation which correlate them—*i.e.*, teleorganic changes. And since there can be no existence without change, the intuition of cause is a fundamental causal

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* *History of Scientific Ideas*, 3d edit. vol. i. p. 88.

† *Ibid.* vol. i. p. 856.

‡ My friend and colleague, Professor Goodsir, lately read an interesting paper to the Royal Society of Edinburgh on the anatomy of the knee-joint, in which he very ably showed how its articulating surfaces were developed according to fixed geometrical principles.

idea, and, like the intuition of unity, is an essential element of all our cognitions. The primary derivative ideas of this intuition, or the axioms as to causation, need only be enumerated to show their teleiotic relation to the correlative ideas in the law of design:—1. "Nothing can take place without a cause." 2. "Effects are proportional to their causes, and causes are measured by their effects —*i.e.*, force = force." 3. "Reaction is equal and opposite to action." This is identical with the preceding. These ideas are all included in the fundamental teleiotic idea of necessary and inevitable order and sequence of phenomena (150), and as such are realised in the consciousness as fundamental truths. The intuitions of Power and Substance are derivatives or isomerics of the intuition of Cause.

500. Now, these are the fundamental intuitions of the great group of the inductive sciences, in which the results of observation and experience as to the order of events, or of the successions and co-existences of phenomena, are formularised in general principles. The primary group of this class is that of the mechanico-chemical sciences, including, besides all departments of chemistry, the sciences which deal with the molecular forces—namely, light, heat, galvanism, electricity, magnetism. Derivative from these are those which add the fundamental intuitions of consciousness as to the influence of the molecular forces on the organism, in which are included optics and acoustics.

501. *Form, Limits, and Symmetry* are the fundamental intuitions of the sciences of construction, and of the fine arts as distinguished from the constructive. Strength and Perfection in construction and Beauty of Form or outline are correlative. But these remarks apply to visible form alone; whereas we know that as form is only

a manifestation of force, there are as many kinds of form as there are forces (234).

502. Sensation, considered as the feeling of pleasure or pain, enters into the fine arts as a necessary element. Architecture, being a *constructive* art, is not obliged, as such, to take the æsthetical element into consideration; nevertheless a perfectly constructed building, being necessarily the expression of an equilibrium of forces, must be also beautiful in form. This is perceived in or by the vibrations of an elastic medium or æther, which excite certain pleasurable or painful states of consciousness whenever we cognise the colour, form, and sound of bodies. These, when in affinity with our ideagenic substrata, are said to be in harmony.

503. *Harmony* may be absolute or contingent; or in other words, the affinitive impressions thus reaching the encephalon through the eye and ear may be in affinity either with substrata developed according to teleiotic ideas, or with those which arise during experience, and which are the basis of habit and association. Now, it is only in the former case that harmony is absolute, and is the cause of our intuitive perceptions of the Beautiful in colour, form, and sound. In the latter case, it is simply the ever-varying cause of the Pleasing; things are in relation with ourselves only, and therefore may be not only not Beautiful, but even Ugly in the abstract sense.

504. Harmony, therefore, as a scientific principle of æsthetics, arises when the vibrations referred to are isodynamic; or in other words, are developed according to such numerical ratios as, if applied to Form, would determine Symmetry. Consequently, harmony in the arts of music and painting is correlative with symmetry in architecture and sculpture, and the constructive Arts.

It is in this way that both the fine arts and arts proper (including design in manufacture) are all based upon the same fundamental intuitions. And as these, in their turn, are but the exponents to the consciousness of certain laws or modes of operation of force, they rest finally upon the primary intuitions of Time, Space, and Number. Hence it is that the principles of æsthetics in general are fundamentally geometrical (244, 245).

505. In an essay on the functions of the brain, lately published, I have attempted to show the *genesis* of our ideas of the Beautiful according to my doctrines of the correlative development of teleiotic ideas in organisation and noetic ideas in thought.* To illustrate them, I adopted the doctrines of Mr D. R. Hay, who, with great labour and singular depth of thought, has built up a geometrical theory of the Beautiful which is equally applicable to the æsthetics of Form, Colour, and Sound. The laws of the Beautiful as to these (he shows) can all be resolved into certain fundamental numerical ratios, which may be determined experimentally or deduced *à priori*, and which contain within them an endless variety of derivative laws. So that just as out of a fundamental law of design all things in creation are evolved in reciprocally adapted relation, and the law of development from the general to the special regulates all the phenomena of organisation, so the endless modification of simple uniform ratios into multiplicity or variety is the fundamental law of the Beautiful. Hence all our intuitions of the Beautiful in nature correlate the results of the teleiotic ideas operative in nature, whatever those may be. These find their highest develop-

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* "Further Researches into the Reflex Function of the Brain," *Brit. and For. Med.-Chir. Review*, July 1855; and *Psychol. Jour.*, Oct. 1855.

ment in the human form; consequently the intuitions of, or instinctive feelings for, beauty of form and expression in man, must correlate the numerical laws of beautiful development and perfect muscular action, determined by experiment and observation. "The highest degree of beauty in nature," Mr Hay remarks, "is the result of an equal balance of uniformity with variety. Of this the human figure is an example: because when it is of those proportions universally acknowledged to be perfect, its uniformity bears to its variety an apparently equal ratio. The harmony of combination in the normal proportion of its parts, and the beautifully simple harmony of succession in the normal melody of its softly undulating outline, are the perfections of symmetrical beauty; while the innumerable changes upon the contour, which arise from the actions and attitudes occasioned by the various emotions of the mind, are calculated to produce every species of picturesque beauty, from the softest and most pleasing to the grandest and most sublime."* We have already seen this principle evolved *à priori;* Mr Hay affords the proof by scientific research based on a pure science.

506. *Intuitions of the Ludicrous and Grotesque.*—All the derivatives of Form enter into the principles of æsthetics, such as Multiplicity, Repetition, Rhythm, and the like; but the fundamental teleiotic idea of aberration or contingency is itself the correlative of an intuition which is the basis of a particular department of Art—namely, the Ludicrous or Grotesque, and Horrible. Every teleiotic idea includes perfection; correlative with this is imperfection (305). Morphic imperfection, when in synthesis with certain feelings, excites certain other derivative intuitions—the feeling of the absurd and ludicrous (358), or

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* *The Science of Beauty, as developed in Nature and applied in Art.* by D. R. Hay, F.R.S.E. (Edinburgh, 1856), p. 12.

of the disgusting, horrible, &c. The intuitions of the ludicrous and grotesque are therefore necessarily lower or more imperfect than of the perfect and complete. Hence a monkey is grotesquely like a man. Hence animals dressed in human habiliments excite the feeling of the grotesque. Hence the reality of the distinction between High Art, which deals with all the developed things of humanity, and Low Art, which deals with its foibles and imperfections, as in caricature.*

507. Now, these intuitions, of whatever class, are the elements of *Art* proper, as distinguished from Science. They are the basis of those empirical principles (the results of experience) which are usually termed *the* Principles of Art, as distinguished from the principles of a

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* The works of Art of "spirit mediums" and the insane are exceedingly instructive as to the influence of the æsthetical intuitions on the automatic action of the brain. I have been enabled, by the enlightened kindness of gentlemen interested in practical psychology, to show to my class of medical psychology numerous drawings, the work of "spirit mediums" and of the insane, highly illustrative of this automatic influence of the intuitions of Symmetry, Harmony, serial Repetition, and the like, upon the production of representations of æsthetic ideas. Gentlemen in communication with the classes of persons referred to, would oblige the author much if they would favour him with specimens of their Art, however humble and grotesque; and also of their handwriting and literary composition. For the purposes of scientific comparison and deduction, it would be exceedingly valuable to add examples of their early attempts at art or writing, either in youth or later; and also to give specimens in series of the morbid drawings, so as to show the character they assumed with progressive morbid changes or declension in the faculties. It is not unusual to find an educated man drawing, writing, and spelling in the last stages as he wrote and spelled in boyhood—Art-effort thus going back, like memory, in diseased states, to the earliest periods of life. It is by the collection and comparison of facts like these that substantial progress will be made in mental physiology and pathology.

Science of the Beautiful, or of Art. These empirical principles only show how the beautiful or artistic in form and colour may be attained, either by copying nature servilely, or blindly guessing and labouring at the connection between the laws of form in nature, and the intuitive feeling of, and belief in, the Beautiful. On the other hand, the principles of a science of the Beautiful indicate the causal connection between these.

508. The same polemic which runs through the whole of science and philosophy has been constantly manifested in Art. To the question, What is beauty? the answers have usually had reference exclusively either to the Absolute, or to the Contingent. On the one side, principles have been set forth which are based upon a copying of nature; on the other, the mere feeling or intuition of the Beautiful has been the elementary basis of the theories. This, however, may be wholly contingent, or, in artistic phrase, conventional. The true theory of the Beautiful includes the two sides of the shield. The intuitions must be evolved into science and art by experience of the correlative teleiotic ideas in phenomena. "I have had but one steady aim in all that I have ever tried to teach—namely, to declare that whatever was great in human art was the expression of man's delight in God's work,"* is a comprehensive declaration of a well-founded intuition of true art.

509. The intuition of *design* correlates that of *cause*. It is the intuition necessarily associated with the intuition of the exercise of Power as Will. These two intuitions are at the foundation of all the sciences which treat of human reason and will, and therefore of metaphysics, logic, and ethics. It is obviously in correlation

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* *The Two Paths*, being Lectures on Art, by John Ruskin, M.A. (1859), p. 50.

with the teleiotic idea of the law of adaptation to ends, and as such is the foundation of all natural religion. Hence natural theology and palætiology* are in the closest relation as sciences, and meet in all the discussions of biblical geology.

510. The fundamental intuitions of *Truth* and *Perfection* correlate the law of inevitable and unchangeable order to ends (312). They are the fundamental ideas of the moral sciences of natural theology, and of religion, whether natural or revealed (312). These intuitions are peculiarly human, and are the basis of all that struggle after higher and higher attainments in science, art, religion, and all the business of life, which distinguishes man from all his fellow-creatures (171, 172).†

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* Dr Whewell. *Hist. of Inductive Sciences*, vol. iii. p. 397.

† The reader will find, in a work just published by Dr M'Cosh, Professor of Logic and Metaphysics, Belfast, entitled, *The Intuitions of the Mind*, an interesting exposition of the philosophy of the Intuitions from the metaphysical point of view.

CHAPTER IX.

THE UNITY OF THE LAWS OF LIFE AND THOUGHT.

511. Having thus considered the fundamental relations of Feeling, Thought, and Will, to Biotic Ideas and to each other, it will be well to take a general survey of the whole phenomena of Life and Consciousness, so as the better to comprehend their unity. Now to this end there is no more available starting-point than the idea of unity itself.

512. Looking at unity as a causal idea of evolution of states of existence into states of consciousness, we find that three successional modes of the latter, which result from it, have to be correlated;—namely, 1. The desire for unity; 2. The "conation" or act of energy to attain unity; 3. The knowledge of the ends to be attained in fulfilment of the desire and act. Now, as these ends will necessarily be correlative with biotic ideas as vital energies, and with intuitions or intuitive ideas as mental energies, the correlative vital processes in both classes of energies will be integration and differentiation, with their derivative or correlative processes.

513. The desire for unity is operative to the attainment of five fundamental ends of existence:—1. Existence as one in time and space, or the maintenance of the individual. 2. Continuance or maintenance of the species in time and space, of which the basis is the union of the sperm-cell and germ-cell, by union of the sexes, and union

of the offspring with the parents in families. 3. Union or combination of individuals or families in society, to the end that the race may be maintained and developed. 4. Union of all cognitions and experience in harmonious relation to each other, so as to constitute them into one system, or body of knowledge. 5. Union with the First Cause, or the Divine Mind, to the end that the final cause of man's existence may be attained. The desire for these ends is that state of the affective feelings termed Love by moralists.

514. Now, this Desire for unity may be traced through all the derivative desires and energies by which these five ends are sought to be attained; and therewith there will be a manifestation of all the derivative cognitions, feelings, and faculties which make up the great departments of science and art, inasmuch as these are themselves in causal relation to the primary or most general intuitive idea (157, 160).

515. *Self-love.*—An examination of the desire for continued Existence as One in space and time need not detain us, since it has been already examined throughout its successive evolutions and relations; so that the preceding doctrines of a scientific Biology and Psychology may be taken as a sufficient exposition of the operation of the idea of unity, in evolving the phenomena of human nature in general, considered as founded on self-love.

516. *Love of the Sexes.*—The second desire is that to continue the species in time and space; a desire which correlates the unity of Life and Organisation in time and space (259-261). To attain this end, the union of a sperm-cell and germ-cell derived from individuals in affinitive relations, or resembling each other—*i.e.*, of the same and not of a different species—is necessary, so that they shall integrate or become one. Now, each sperm-cell and

germ-cell is an integration, potentially, of all the tendencies or characters of the perfect or adult individual from which the cell is produced (291). In organisms, generally, this union of the two cells is secured by a singular variety of curious vital mechanism. In conscious organisms, the completion of this union is the gratification of the desire for union of the sexes; in all animals, the desire itself is one of the strongest and most fundamental of all states of consciousness.

517. *Love of Offspring.*—Now, although nothing can be more striking than the unity of the law of physical or sexual love in all the multiplicity of the processes by which the union of the sexes is attained, and thus the integration of the two affinitive cells—the sperm-cell and germ-cell—secured; yet, after this first and most essential step is completed, provision has to be made for the protection and alimentation of the young organism which results from that integration, while it is still incapable of self-alimentation or self-defence. This end is attained by the development of the paternal and maternal instincts, in the form of the *storge*, or love of offspring. In lower social animals, the continuance of the species and the care of the young is usually the sole object of their union in society; so that, when these objects are attained, the society is either partially or wholly dissolved. In man (the most social of all animals), the idea and the desire are at the basis of all society, of the social affections, and of all the happiness of domestic life.

518. Now, the influence of the desire for sexual union or love, in the popular sense, and of family union, on the evolution of all the higher feelings and sentiments of man, is very strongly shown. Before the union takes place, the æsthetic feelings are greatly developed.

Thus music, poetry, and song are often first practised by the man when he first "falls in love;" a beautiful ideal fills the soul, and sometimes appears on the canvass; and a tendency to personal decoration is more than ever manifested. These feelings, however, as to form and colour, are nothing else than the correlatives of that biotic evolution of the Beautiful which is the great characteristic of puberty in animals, and of fitness to continue the species in plants; while, as to sound, the "lover, sighing like furnace, with woeful ballad made to his mistress' eyebrow," is but manifesting the operation of the same biotic idea which impels the male *cicada* and song-bird to vocalise to their mates.

519. But the mental character changes much under the influence of this passion. In lower animals, courage and audacity are manifested in males, *pari passu* with the development of the sexual feeling. In man, not only are these masculine qualities shown, but even the higher virtues are evolved under the influence of a virtuous attachment. Such is the experience of many observers of human nature.

> . . . . "For indeed I know
> Of no more subtle master under heaven
> Than is the maiden-passion for a maid;
> Not only to keep down the base in man,
> But teach high thought, and amiable words,
> And courtliness, and the desire of fame,
> And love of truth, and all that makes a man."*

520. The influence of love and maternity upon the corporeal form and mental character of woman is quite as striking. While the form is evolved into graceful outlines, and the face becomes more beaming with every

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* *The Idylls of the King*—"Guinevere." By Alfred Tennyson, Poet-Laureate.

changing expression, the mind and the feelings are equally developed, and the loving instinct of woman is manifested in all its extent. It thus happens, as I have elsewhere said, that "the circle of family relations—husband, son, and brother—is to the true woman, and to all she blesses with her presence, 'a perpetual fountain' of domestic sweets."* Happy with these objects upon which to lavish her love, she wants none else,—

> . . . . . "To know no more,
> Is woman's highest knowledge and her praise."

521. The laws of marriage, and the ceremonies which in all races and in all ages have celebrated or sanctified the union of the sexes, manifest the operation of the same law of development. Thus the ceremonial is often one in which the fine arts reach their highest pitch. Not only is the bride decked "in glorious array," but whenever wealth and rank permit the display (as in a royal marriage), Music, Painting, and Poetry lend their aid to celebrate the union of the pair. An analogous process is seen in lower organisms: thus, during the short nocturnal period when the sperm-cell and germ-cell of the *Victoria regia* lily are being brought into union, the flower is most beautiful in form, colour, and perfume; so that "Solomon in all his glory was not arrayed like one of these." Equally gorgeous at this period are various butterflies and birds amongst the articulata and vertebrata.

522. In proportion as unity of the sexes is complete.

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* For special illustrations of the influence of biotic ideas on the corporeal and mental characteristics of the sexes, compare the author's *Treatise on the Nervous Diseases of Women*, part i. chaps. ii.–v.; also "Woman in her Psychological Relations," *Jour. of Psychol. Medicine*, Jan. 1851, pp. 8–44.

and they twain become intimately one in all truth and perfection, so is the happiness of married life secured, the continuance of the species maintained, and society established on a solid foundation of virtue and morals. The unity of the species, the unity of domestic life, and the unity of society (and unity here correlates perfection), are thus closely related, because dependent upon the same fundamental idea, and law, and desire.

523. *Social Union.*—The development of human society is nothing else than the socialistic evolution of the teleiotic idea of unity (294). The desire for union and communion with his fellow-men is the fundamental desire of man as a social animal. And out of this desire arise all those high motives and social efforts, excited by the love of country, and which characterise the patriotic hero. *Vir bonus est quis? Qui consulta patrium, qui leges juraque servat.*

524. This desire for social union is shown in the operation of various social derivative ideas. Thus it is the cause of all those infinitely varying combinations of men for a common object, which arise when man is free to carry into effect the social motives which actuate him. It is from this source that the stimulus is derived which, in free countries like Great Britain and the United States, impels men to the formation of all those institutions, companies, associations, clubs, benefit societies, masonic lodges, and religious sects, that so remarkably characterise their social polity. Such freedom of combination is the best guarantee for individual freedom and national stability and progress; for where the mental forces are left free to act, that isodynamical equilibrium of conflicting forces is secured, which is equally necessary for strength, stability, and perfection in the construction of society, as in the construction of an edifice or an organism.

525. This tendency to social integration is shown ethnically, on a large scale, in Europe at the present moment, by the agitation going on for a combination or a union of races. To this is due the agitation for Teutonic unity in Germany, for Italian unity in Italy, for Panslavism or the union under one government of the Slavonic races. The teleiotic idea of unity, thus operating throughout affinitive nations, insensibly lays the foundation for extensive wars, and great changes in territorial distribution of power. Great Britain tends essentially towards the Teutonic race, although, with her mixed population, ethnically, she only tends to alliances, and not to union.

526. Theories of government arise out of this desire for unity, and its antithesis dichotomy. In the Celtic races, the unitarian tendencies seem to prevail, to the detriment of personal freedom. Thus, the socialistic theories of Fourier, Owen, St Simon, and others, like "the republic, one and indivisible" of the French revolutionists, include schemes which strike at the root of individual freedom of action. On the other hand, the dichotomising tendency manifested in the United States threatens to divide a powerful republic into smaller nationalities.

527. It is in the theories of religious unity, however, that the unifying desire operates the most strikingly. "One God, one Faith, one Baptism," is by no means an idea of religious unity peculiar to Christianity. The desire for identity of religious faith and unity of ecclesiastical ceremonial and order has been manifested in all ages of the world, and has proved more fertile in good and evil than even the desire for political unity. It has been the cause of the longest and most destructive wars ever waged in Europe and Asia; and even now it threatens once more, by its undue development, to excite the opposite

or correlative idea into activity, and again set the most civilised nations of the world in deadly antagonism. This desire for ecclesiastical and ceremonial unity derives its greater intensity from the desire out of which these spring—namely, union with God as the First Cause of order.

528. In all these social manifestations of the desire for unity, the idea is evolved into the constructive arts. Hence, when commerce and manufactures have been successfully developed by the operation of the idea, by leading men to co-operate for the common objects which they offer, the next step is a manifestation of the æsthetic elements: then town-halls or stately palaces arise in the large and flourishing commercial cities. The most remarkable illustrations of this æsthetic and constructive evolution of the idea of social unity have been erected by two free nations—namely, the British House of Parliament, and the Capitol at Washington.

529. *The Idea and Desire for Unity of Knowledge.*—The desire for unity of thought is so fundamental and universal, that it is difficult to select any special illustration of it. In our acts of intelligence we intuitively desire to generalise and unite under one head or conception an infinite variety of subordinate conceptions. The desire is, in fact, the basis of all the inductive processes which are spontaneously and instinctively performed (375).

530. Sir William Hamilton distinguishes two causes of philosophy: the one is the necessity we feel to connect causes and effects; the other the desire to carry up our knowledge into unity. The latter, he says, is the "desire of unity," and is one of the most prominent characteristics of the human mind. He adduces various "testimonies to the love of unity"—(to use the express terms of the marginal reading of the following para-

graph):—"The history of philosophy is only the history of this tendency; and philosophers have amply testified to its reality. 'The mind,' says Anaxagoras, 'only knows when it subdues its objects, when it reduces the many to the one.' 'All knowledge,' say the Platonists, 'is the gathering up into one, and the indivisible apprehension of this unity by the knowing mind.' Leibnitz and Kant have, in like manner, defined knowledge by the representation of multitude in unity. 'The end of philosophy,' says Plato, 'is the intuition of unity;' and Plotinus, among many others, observes, that our knowledge is perfect as it is one. The love of unity is by Aristotle applied to solve a multitude of psychological phenomena.* St Augustin even analyses pain into a feeling of the frustration of unity: 'Quid est enim aliud dolor, nisi quidam sensus divisionis vel corruptionis impatiens? Unde luce clarius apparet, quam sit illa anima in sui corporis universitate avida unitatis et tenax.'† St Augustin applied the principle of unity to solve the theory of the Beautiful: 'Omnis pulchritudinis forma unitas est.' (*Epist.* xviii.)"‡

531. It cannot be doubted, as Sir William Hamilton shows, that this love of unity has had a powerful influence upon scientific development. There is, perhaps, no comprehensive modern theory of life and organisation,

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* "See *De Memoriâ*, § 5, for application of this principle to the problem of Reminiscence. Cf. *Reid's Works*, p. 908. See also *Problems*, xviii. 9, where it is used to explain the higher pleasure we derive from those narratives that relate to a single subject." (*Editorial Note.*)

† *De Libero Arbitrio*, lib. iii. 23.

‡ *Lectures on Metaphysics*, vol. i. p. 69. Several learned editorial foot-notes and references appended to this passage are omitted for the sake of brevity; the attention of the reader is however specially called to them.

or of cosmogony, which is not only based upon the idea as a truth, but manifests the love of it as a desire. Mention need only be made of the theories of Goethe and of Oken, of Cuvier, St Hilaire, Blainville, Grant, Owen, and others, to establish this fact; or of such works as the *Vestiges of the Natural History of Creation*, the *Unity of Worlds* (by the Rev. Baden Powell), and others, for proof how the desire for unity of conception and theory interpenetrates all science. Nor, according to the nature of things, could it be otherwise. All things are in relation to each other as a whole in virtue of the fundamental law of design; man necessarily desires to know the results of that law, and he must therefore ever struggle after a unity of knowledge of creation.

532. The social and æsthetical evolutions of the love of knowledge as unity is manifested in universities; the word itself is sufficiently indicative of the idea which excites to their establishment. Derivative from this idea are those which lead to the building and endowment of colleges and schools, and the establishment of societies for the culture of special departments of knowledge, or for the purpose of unifying those societies into combined action. Such an idea has given origin to the British Association for the Advancement of Science, the object of which is to bring together the members of geological, botanical, zoological, ethnological, and other societies, so as to unite them in action to a common end.

533. Now, it cannot be doubted that this love of unity may lead to an erroneous application of the fundamental truth or idea to religion, sociology, and scientific research. In the *first* place, it has led men to forget the antithetic or correlative truths, ideas, and desires—the idea of the Many, of freedom (or change), of contingency. *Secondly*, It has been erroneously applied to things not in relation

to each other. Of the latter class is the instance mentioned by Reid, of a musician who thought there could be only three parts in harmony—to wit, bass, tenor, and treble—because there are but three persons in the Trinity; and of which a thousand similar instances might be quoted. Of the former are numerous theories in civil and ecclesiastical government, the basis of which is a principle of enforced unity amongst heterogeneous or irrelative elements—or, in other words, theories of civil and religious autocracy; and it is often manifested as insanity as well as error.

534. Sir W. Hamilton shortly describes the influence of this erroneous desire for unity on cosmological and intellectual systems:—"It is this tendency, indeed, which has principally determined philosophers to neglect or violate the original duality of consciousness; in which, as an ultimate fact—a self and not-self—mind knowing and matter known are given in counterpoise and mutual opposition; and hence the three unitarian schemes of Materialism, Idealism, and Absolute Identity. In fine, Pantheism, or the doctrine which identifies mind and matter—the Creator and the creature—God and the universe,—how are we to explain the prevalence of this modification of atheism in the most ancient and the most recent times? Simply because it carries our love of unity to its highest fruition."*

535. In political and religious movements the love of unity is apt to develop tyranny and intolerance, not the less because the antagonistic principle of duality, by dichotomy or disintegration, is not operative. It is deducible *à priori* from the truths of teleology, as well as inductively from the facts of experience, that in all combinations of men there will necessarily be a dual arrange-

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* *Lectures on Metaphysics*, vol. i. p. 73.

ment or a division into two parties, or else disintegration and a division into several parties. The latter is an obstacle to combined energy, for it needs the preliminary step of integration of the discordant elements into synthetical unity—*i.e.*, one and one in relation. All bodies of men aiming at united action thus dichotomise; the result may be either united action or separation. When it is the latter, a process analogous to generation or multiplication by buds takes place, so that the units thus separated dichotomise again, either with a view to development and common action, or separation.

536. *The Love of God*, or the desire for union with God, is, however, the culminating desire of human nature. It is the foundation of all religion—is in truth the essence of religion: union in this life, but more earnestly union in the life to come. This desire is most manifested as the love of God in the two most widely-spread and most intellectual forms of religion, viz. Christianity and Buddhism. It is a chief element of those portions of the literature of religion which expresses the religious feelings. Thus Wesley, one of the best of religious poets, writes,—

> "Eager for Thee I ask and pant;
> So strong the principle divine,
> Carries me out with sweet constraint,
> Till all my hallowed soul is Thine;
> Plunged in the Godhead's deepest sea,
> And lost in Thine immensity!"

537. The early religious speculations of the Indians were of a similar character as regards the love of God. Husband, wife, children, were only loved in and through Him. "This Spirit (the *ātmā*, the Absolute Self) it is which we love when we seem to love wealth, Brahmans

Kshatriyas, this world, the gods, all beings, this universe."*

538. And this love of God, when enlightened and pure, is coincident, like the virtuous love of the sexes, with an elevation of the whole nature of man. It seems to make him Godlike in all moral qualities; to raise him from earth to heaven; to bring out the highest powers of his moral, intellectual, and æsthetic nature. Whatever is beneficent in act, or grand or beautiful in Art, has been developed as a manifestation of man's love to God. The greatest monuments of Greece and Egypt are the temples of God; the finest poesy is that which sets forth His praises. It is only lately in England that the love of country has been expressed in architecture at all comparable with the ecclesiastical; and without question the grandest buildings, generally, in the world, are those dedicated to the worship of God. In some of these costly European structures, music and painting and sculpture find their highest development. A dim antiquity solemnizes the statues of Christian saints and heroes. The measured chant of praise is daily uttered by priests and choristers clad in gorgeous vestments; and *Te Deum laudamus* peals from a choir magnificent with gold and purple, to re-echo amongst pillars of the most graceful symmetry, and from roofs rich with all manner of decoration.

539. *The Love of Heaven*, or the desire for future union with God.—This development on earth of the love of God, or desire of union with the First Cause of all things, is, however, only an anticipation of a more complete union after death. Unity and perfection correlate each other. The law of evolution of an archetypal idea is that

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* Quotation in Professor Max Müller's *History of Ancient Sanskrit Literature*, p. 23.

of a continually expanding progress towards perfection (160), through ever-increasing differentations and integrations. Such is the law of evolution of the archetypal idea of man; and as he is the most fully evolved, so he is the most perfect of terrestrial animals. But the question arises whether the human archetypal idea is so completely evolved on earth, that man has already attained his designed perfection; or whether it is still in process of evolution, and has yet to be evolved through an indefinite period of time.

540. Now, there are two current doctrines on this point, which are both founded upon a fundamental and intuitive desire of man's nature—viz., the desire to attain perfection. "Man never is, but always to be blest." He is ever looking to the future for something more perfect than the present. As to terrestrial development and social life, the doctrine of progressive development, evolved from this intuitive desire, is apparently fully established as a practical doctrine of experience, so that a constant amelioration of man's social condition, and a higher development of his powers, is now the acknowledged aim of all legislation, philosophy, and science.

541. This doctrine, however, applies only to the continually increasing perfection of the species. Is it equally true of the individual? To answer this question is perhaps, in truth, beyond our powers; but we may venture to speculate at least regarding it. If it be true, then, as the doctrine of a continuously progressive development of the individual, it implies the doctrine of unceasing existence; and therewith of a life after death, which will be characterised by a continuous evolution of man's spiritual nature from age to age. These two doctrines as to the species and the individual Man are therefore the counterpart of each other; the one includes the doctrine of the

permanent identity of the species, the other of the continuous identity of the individual.

542. Now, I think it may be assumed that these notions as to the future of the species and of the individual have their origin in that teleiotic idea of the future, and what it contains, which runs through the whole of creation (218, 361). Consequently, in man, the development of the idea as to a future life necessarily includes the idea of a future state of increasing happiness and perfection. Heaven is the hoped-for gratification in another world of those desires, whatever they may be which are unattainable in this—whether they be sensual, intellectual, or religious. There the Indian hopes to enjoy the best of hunting grounds, with "his faithful dog to bear him company." There the follower of Mahomet hopes to perfectly enjoy sensual delights with the houris. So, also, a future union with God is inculcated by the code of Manu of the Hindoo mythology: "Beholding the Supreme Soul in all beings, and all beings in the Supreme Soul, and offering up one's own soul as if in sacrifice, man becomes identified with the glorious Self-existing One—his individuality merging into and losing itself in the Divine Essence." "Thus the man" (such are the concluding words of the code) "who in his own soul recognises the Soul Supreme, present throughout all creation, obtains the happiest lot of all—to be absorbed into Brahma."*

543. So also the Christian looks forward to heaven. There will be attained that perfect union with the Divine for which the good man vainly struggles here. There knowledge will be perfect; for "what we know not now, we shall know hereafter." There will be the highest æsthetical development, for all will be beauty, harmony,

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* *Blackwood's Magazine*, vol. lxxxv. (March 1859), p. 321.

truth, love. The fashion of this world will have passed away, so that the contingent and derivative results of the law of design, which consist in imperfection, disorder, pain, and death, will cease. The war of antagonising elements, the struggle of life, will be over. The Absolute will be All in All. Such is the future life which the Christian hopes for and believes in.* This Christian doctrine only illustrates the great fact of mental causation, that whenever the intuition of a future state of human existence after death has attained its highest notional development, it has been evolved into the doctrine of an absolute existence in union and communion with the Absolute. So that the union and communion of man with God on earth is felt to be but the antetype of union and communion with Him in heaven, or in a future state of existence, when every result of the law of design will be perfect, or, in other words, the Relative lost in the Absolute.

544. But the important question arises, Is this idea of a future state a true teleiotic idea? Is there a future life for man in which a higher differentiation of his powers will take place? In attempting to solve this question, we may start from the fact that there is no race of men, at all advanced beyond the lowest barbarism, which has not an intuition of a life after death.

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* "And I heard a great voice out of heaven, saying, Behold, the tabernacle of God is with men, and he will dwell with them, and they shall be his people, and God himself shall be with them, and be their God. And God shall wipe away all tears from their eyes; and there shall be no more death, neither sorrow nor crying, neither shall there be any more pain: for the former things have passed away. . . . And there shall in no wise enter into it anything that defileth, neither whatsoever worketh abomination or maketh a lie" (*Rev.* chap. xxi. ver. 3–4, 27). "And there shall be no more curse" (chap. xxii. ver. 3).

And this has operated as a law of man's nature in all past ages; for whether we examine the ancient Indian, Egyptian, Grecian, or Roman mythologies, we find this intuition is the foundation of them all alike. There is an apparent exception amongst civilised nations in the omission of the doctrine from the Mosaic or Hebrew system of religion; for it is a remarkable circumstance, that throughout the five books of Moses positive mention is nowhere made of a future state of reward and punishment. All the promises and threatenings of the code have exclusive reference to future national blessings and disasters on earth. It cannot be conceived possible, however, that Moses or the people he governed were ignorant of the views of the Egyptians—amongst whom they had lived and been educated—as to a future state; for these were not only of a most definite character, but were interwoven with the most solemn of their religious rites—namely, the funereal. Besides, that the doctrine was well known to the Jews, is shown by the fact that, at a later period, the opposing sects of the Sadducees and the Pharisees represented the differences of opinion as to a future life subsequently current amongst that people.

545. An exception to the universality of an intuition of a future state amongst all mankind is found in the apparent defect of any such doctrine amongst unlettered and barbarous men, like the Australian aborigines. It is difficult to say conclusively that such an idea is wanting amongst them, because the meaning of abstract terms is not of easy interpretation, even in an old language like the Chinese; but fully granting the fact, it cannot be denied that the intuition of God and of a future state are potentially a part of their mental endowments, and that, therefore, these undeveloped men are capable, at least, of feeling the intuition, and perceiving its truth, so soon as

their minds are subjected to the appropriate stimuli from without—*i.e.*, developed into higher powers. Now, this potentiality of intuitional belief correlates the potentiality of archetypal development; so that, for the same reason that an ape cannot be developed into a man, for the same reason it cannot comprehend God, or union with him in a future state of existence.

546. Nor is it any argument against the probability of a future life to individual man that we cannot conceive how man can exist in another world, nor what that world may be. Such notions are only possible as the educts of experience; they are the results of the development of intuitions, by affinitive impressions derived from external phenomena. Consequently, as man's present organisation is adapted exclusively to the experience of phenomena of terrestrial things, he cannot pass beyond them in knowledge; he can only imagine, and his imaginations will all be of the earth and earthly.

547. It follows, then, that although man cannot, from the constitution of his nature, comprehend the Infinite, nor understand how he can continue to exist, and know and love God, in a future life; yet he has intuitions which are evidence as conclusive that there is a God, and another life after the grave, as his personal intuitions of his existence at present, of his previous existence in past time, and of his continued existence into the next moment, are conclusive as to his personal identity. And so the highest, and greatest, and last, of the intuitive beliefs of his intellect combine in unity with the first, and simplest, and lowest.

548. Finally, it is in the capabilities of man's nature as to the future in which the great difference between him and his fellow-creatures, the lower animals, lies. They do not appear to be capable of a knowledge of God, or of a

future beyond the grave. The gorilla—the ape nearest man in development—is probably as widely apart from man in this respect as the lowest vertebrate. In other words, it is not the corporeal form which should assign man his place in creation, but his mind. What this is in its relations to God we have already discussed, and concluded, as a question of zoological Ontology, that "We are His offspring."

PART V.

PRINCIPLES OF A MENTAL PHYSIOLOGY.

INTRODUCTION.

Mental Physiology, considered as a science, should set forth the general laws of Life and Consciousness as they are correlative in the individual or concrete *Ego;* so that from the order of mental sequences we should be able to deduce the order of vital sequences, and *vice versa*. Now to this end it is necessary to determine, in the first instance, the order of vital processes, as they correlate biotic laws independently of consciousness; and to ascend from these, as the most universal and most general phenomena and laws, to the derivative and particular, as seen in their most complete evolution in correlation with conscious states. We should therefore have to commence our inquiry with the simplest vital phenomena, whether of plants or animals, and indicate the evolution of the fundamental biotic ideas through all the teleological processes of nutrition, growth, and multiplication. Then we should pass from these to the instincts proper; and from these again into the higher instincts and sentiments, until we reach the faculties of the understanding and reason, in unity with all below, in virtue of a regular series of ever-expanding organismic developments.

549. A systematic exposition of the developmental operation of the fundamental laws of life throughout all forms of life, according to this method, would finally evolve the structure and laws of action of the nervous system, and through these the structure and laws of action of the encephalon, as the organ of thought. For various reasons, however, which need not be detailed here, such an exposition is not possible. It behoves us, therefore, to be content with a more limited range of inquiry, and show the relations of these primary laws to the fundamental tissues of plants and animals, to their fundamental systems of organs, and to the modes in which both tissues and organs are evolved, and combine in action, as instincts, to the common end of their formation and activity—the maintenance and well-being of the individual and the species in time and space. This course of inquiry, while necessarily developing a *Mental Physiology*, would lead us to the fundamental principles of a MENTAL ORGANOLOGY, or a doctrine of organisation in relation to the varied states of consciousness which constitute in their totality the mental life of man. And this is perhaps all that can be done in the present state of our knowledge. We are certainly in a position to indicate, generally at least, the organological relations of the cerebro-spinal axis to the animal instincts proper, the feelings, and the mental faculties; and, more particularly, we can formularise some of the results, as manifested in the nervous system and in life and organisation generally, of those laws of differentiation and integration whereby tissues and organs are developed and co-ordinated, and the various vital processes subservient to the ends of existence manifested in unity.

550. Now, the entire scope of the doctrines laid down is to establish the law of multiplicity in unity of all organisms. And as the law receives its highest manifestation in the structure and functions of the encephalon, and as this has been and is still questioned by some physiologists, it will be useful to examine the law in its bearings on the structure and functions of that organ, and inquire into the progress of research into cerebral physiology and organology generally, with special reference to this important practical point. The inquiry will indicate how difficult is the investigation, when conducted apart from any guiding principle. More especially it will show how impossible it has been found, in the absence of fundamental principles, to reconcile the unity of all conscious states with a multiplicity of organic tissues, in relation to those states; and how the true idea of the unity of all vital processes in the encephalon has not been reached.

CHAPTER I.

GENERAL DOCTRINE OF THE FUNCTIONS OF THE ENCEPHALON, AS THE SEAT OF THE UNIFYING PROCESSES OF LIFE AND THOUGHT.

551. EXPERIENCE and research alike prove that the encephalon of man (in popular phrase, his "brains") is the seat of all his conscient activities. It is usually divided anatomically into two parts—namely, the brain proper or cerebrum, and the lesser brain or cerebellum. The brain proper is composed mainly of two symmetrical halves, termed the cerebral hemispheres or hemispherical ganglia, and of various structures, also symmetrical, upon which they rest, and with which they are intimately connected. These have each special names, but the most important are designated cerebral ganglia.* The cerebellum, or lesser brain, is composed, like the brain proper, of symmetrical halves, termed lobes, with ganglion-like structures in relation with them. Although generically like the hemispheres in structure, the cerebellar lobes present some

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* Of late years the nomenclature of the various anatomical elements of the encephalon has been altered greatly, mainly to suit successive theories as to their function. In especial, the terms "cerebrum" and "cerebral" have been applied both in a limited sense to the hemispheres, and in the older and more extended sense here adopted. The nomenclature of Mr Solly, in his able work on *The Human Brain* (2d edit. 1857), is, upon the whole, the most satisfactory I know, and is therefore that which I shall adopt, although it must be acknowledged that the entire terminology of encephalic anatomy is most crude.

important differences, both in external character, in the arrangement of their constituent elements, and in their microscopic anatomy. While each of these "brains" is intimately connected with the other, they are both as intimately connected with a central axis, also situate within the cranium, and therefore a part of the encephalon, termed the *medulla oblongata.* This is constituted of several important ganglionic centres, which have received names derived, like those of the cerebral centres, either from their physical characters, or their supposed functions. This axis is in its turn continuous with a continuous line or column of ganglionic symmetrical centres, which, enclosed within the vertebræ as in a bony canal, extends throughout the whole length of the spine, and is termed the *medulla spinalis*, or spinal marrow. The entire series of ganglia, thus enclosed in, and carefully protected by, the bony case of the cranium and vertebral column, are in intimate union, direct or indirect, with all the nerves of the body, and constitute the cerebro-spinal axis, or centre.

552. Now, the first and most fundamental function of the encephalon is its unifying function. 1. It is the structure whereby the man is self-conscious—that is, mentally one. 2. But it is also the organ whereby he acts as one in relation to the external world; and, 3. It is equally the organ whereby all the processes of vegetative life are so influenced that the modes of vital activity reflect and coincide with the modes of mental activity. It is by this organ that the features, gait, tone of voice—*i.e.*, the *physiognomy*—proclaim the man's mental tendencies (381); it is equally by this that the vital and mental tendencies of the parent are impressed, as it were, upon the sperm-cell and germ-cell, and through these upon the primordial cell (291), out of which, in virtue of those

tendencies, a new individual is evolved, bearing a specific and even individual resemblance to his parents, both as to form, function of organs, and mental character. Hence the encephalon is in relation, as a centre of union, with all corporeal processes whatever.

553. The hemispheres of the brain are now generally held to be the seat of those teleorganic processes which are coincident with noetic ideas and the active faculties of the mind. It follows, therefore, that in them, in co-operation with the other encephalic structures, to which they are closely bound by the most intimate connections, all the various modes of mental energy of which they are the seat—whether they be those of attention, memory, will, association of ideas, or the feelings—directly influence not only the voluntary and involuntary systems of muscles, and the secretions and excretions in general, but also all those more hidden and minute changes in the living tissues known as growth, nutrition, repair, and the like. Or, in other words, the functions of the hemispherical ganglia, as the organs of thought and mental action proper, are in unity with all the processes of life whatever, whether they be termed vegetative or animal.*

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* More than twenty years ago I pointed out this law of unity of the organ of thought with all the vegetative processes, whether of the encephalon itself, of the nerves, or of the viscera. I thus explained the influence of attention on the bodily organs, and on the various states of consciousness dependent on the functions of the brain; and I showed how the artificial production of various morbid mental states, by the manipulations of mesmerists, and by the mere volition and other arts of Fakirs, enthusiasts, and impostors of all kinds, could be thus explained. (Vide *Edinburgh Medical and Surgical Journal* (July 1839), p. 16, §§ 46 to 49, and p. 22, §§ 66 to 78. Also chapter x. of my *Treatise on the Nervous Diseases of Women* (London, 1840), p. 109, entitled, "The Action of the Will, and of Internal and External Stimuli on the Hemispherical Ganglia.")

554. If this view of the encephalic functions be correct, it is obvious that it is much more than the common centre of conscious activity, and that consequently those physiologists who have limited their inquiries to its relations to consciousness alone, or to the relations of its parts to a common centre or seat of consciousness—*i.e.*, a *sensorium commune*—have taken too limited a view of its function. For probably there is not any tissue of the body, nor the functions of any of its parts, which are not influenced directly or indirectly by this unifying energy of the encephalon. It follows, therefore, that in this structure we have the final evolution in organisation of the fundamental teleiotic idea of unity, and that it is in truth a differentiation of the properties of all tissues whatever.

555. From this point of view it appears that a true method of inquiry into the laws of the cerebral functions, and into the structure and mutual relations of the parts of the encephalon, can only be based upon an inquiry into the laws of life and organisation, as manifested in the most general mode and in the simplest tissues, whether of plant or animal. To adopt the usual method, and begin the inquiry with the ganglia of the nervous system, is to commence with the complex; the proper commencement is with the phenomena of *irritability* as to adapted acts, and with the phenomena of histological change, as to the processes coincident with adaptation to ends. To set animal-life in opposition to plant-life, or the functions of the nerves and ganglia in opposition to the functions of simpler cell-tissues, is to embarrass the whole subject and render successful inquiry impossible. The tissues subservient to the reflex acts of animal organisms are but differentiations of those tissues which are the seat of plant and animal adaptations to ends; and the brain itself, as the organ of con-

scious design, is but a special structure evolved, like all other vital structures in adaptation to ends, according to the law of design. Being thus the final expression of the archetypal idea upon which the organism is constructed, both as to its parts and as a whole, its function is necessarily that of bringing into unity all the organs and functions subservient to the ends for which the organism exists.

556. But even this would be an imperfect conception of the law by which the encephalon is evolved, for it is necessary to bear in mind that the unifying cause is general in its operation, and that while its most intense form of manifestation is seen in integration of parts of a unit into an organism, it is seen equally in the combination of distinct units into harmonious relation. Thus the teleiotic idea manifested in the integration of the sperm-cell and germ-cell, so that another integer or organism results, is equally active in the combination of distinct integers or organisms into a community. This form of manifestation is seen in organisation in plants generally, and in the lower forms of animal life, such as the Protozoa, Radiata, and lower Articulata and Mollusca. These organisms are societies or communities of individuals. It is this social character, indeed, which gives the plant-like form to the Hydrozoa and Polyzoa, the Polypes and Zoophytes of the older naturalists. The objects of the combination of this social class of organisms are identical with those of the individual. They co-operate—1. To secure a common supply of nutriment through a common system of organs of acquisition or prehension, and digestion, as roots, leaves, tentacula, mouths, stomach. 2. To provide means in common for protection and defence against injurious agencies. 3. To attain most effectually the reproduction and continu-

ance of the species. Hence it is obvious, from the teleiotic point of view, that all the composite plants, the Zoophytes, or plant-like animals, as the Hydrozoa, the Molluscoid Polyzoa, and the lower Articulata, are rather analogous to the social republics of higher animals (as the hymenoptera amongst insects, and man amongst vertebrates) than to individual organisms. We must therefore examine the unifying cause from this double point of view—viz., of integration and combination.

557. Perhaps the best idea of this unity of organisation will be obtained by examining the structure and function of a zoophyte; and for this purpose we will take the Hydrozoa, or Polypes, recently investigated by Mr Huxley.* The body of every hydrozoon is essentially a living sac or animal cell, composed of two membranes, an external and internal, conveniently designated by Professor Allman the *ectoderm* and *endoderm*. The cavity of the sac (the *somatic cavity*) contains a fluid, the *somatic fluid*, charged with nutritive matter in solution, and sometimes, if not always, with suspended solid particles, which seem to perform the functions of the blood in animals of higher organisation. The surfaces of both the membranes are more or less supplied with *cilia*, or minute, hair-like, vibrating instruments. The cilia of the endoderm, aided by the contractions of the walls of the body, are the sole instruments of circulation of the nutritive fluid; the cilia of the ectoderm, aided also by the contractility of the membrane, are the sole respiratory apparatus. They bring the aëriferous fluid into contact with the living tissue, thus acting like lungs. At particular periods tubercular elevations are developed, apparently from the ectoderm, which contain either an ovum or spermatozoa, and are therefore the reproductive organs; and there is a

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* *The Oceanic Hydrozoa.* Ray Society, 1859.

sac for the digestion of food, termed the *polypite*, with its organs of prehension—namely, *tentacula;* and of fixation or attachment—a root-like organ—the *hydrorhiza*. A somatic cavity is usually common to several polypites; and as such is termed by Professor Allman a *cœnosarc*, or "common flesh." The *polypite* constitutes the entire alimentary apparatus of the animal, and not the stomach alone; for it performs the functions of the whole of the "chylopoietic" viscera of higher animals. Its oral extremity is that towards which the animal grows; its opposite extremity is cœcal, and the "root"-end. The *Hydra* is the simplest order of the Hydrozoa; it is a single *polypite*. All the other orders, except the doubtful *Medusidæ*, are social Hydrozoa, or constituted of many *polypites*, with a common receptacle for nutrient material.

558. Now, the interesting point in these simple animals is the homology of their existence (if the phrase may be permitted), both as to their social and individual conditions, to higher animals. As to their social conditions, they offer (after composite plants) the typical form of a community or society of organisms; as to their individual life, they are the analogies of the highest form of teleiotic development. "For it is well known," as Mr Huxley observes, "that in a very early state, the germ even of the highest animals is a more or less complete sac, whose thin wall is divisible into two membranes, an inner and an outer; the latter turned towards the external world, the former in relation with the nutritive fluid—the yelk. The inner layer, as Remak has more particularly shown, undergoes but little histological change, and throughout life remains more particularly devoted to the function of alimentation; while the outer gives rise, by manifold differentiations of its tissue, to those complex

structures which we know as integument, bones, muscles, nerves, and sensory apparatus, and which especially subserve the functions of relation. At the same time, the various organs are produced by a process of budding from one or other or both of these primary layers of the germ."*

559. Now, if we conceive clearly the operation of the teleiotic idea of unity in these simple organisms, we can apply it to the conception of the fundamental laws of union of body and mind—the encephalon being considered as the organ in which the teleiotic idea of unity is fully manifested both in Life and Thought. In the Hydra there is no nerve, no nerve-centre, no brain, no spinal cord; yet the various parts are combined into a perfect organism, and co-operate in function to attain the ends for which it was created, whatever these may be. Here, then, the unifying function can be nowhere else than in the relations which the two membranes hold to each other, to the nutrient fluid, and to the external world. They are in synthesis as the relative and correlative (vol. i. part iii. chap. v.) Everything which touches the apparatus of external relation of the simple hydra, if appropriate thereto, or in biotic affinity, is in external relation to the other parts, but only in common with the external apparatus. And here we discover the first type of that act of consciousness which refers all corporeal sensations or feelings of external things, derived through the sense of touch, to the surface of the body, and, in the case of the other senses, to the external source of the impression, although the teleorganic changes upon which the sensation or state of consciousness depends are wholly internal —*i.e.*, take place in the encephalon.

560. Again, we see in these phenomena the first type

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* *Op. cit.* p. 2.

of those animal movements which, taking place by the intervention of a conducting or internuncial apparatus, stretching between the nerve-centres and the muscles in higher animals, and termed reflex acts, cause the various organs of the body, the functions of which are essentially motor, to move in adaptation to the multitudinous wants of the organism. These variously formed organs are but differentiations of the simple ectoderm and endoderm; and the apparatus of nerves and nerve-centres, which minister to the reception of impressions, to their combination, and their transmission to the proper muscular apparatus, are only differentiations of that unifying element in the simpler tissue which enables the hydrozoon to seize fit alimentary materials, and reject the unfit, to grasp the fitting things with the tentacula in the appropriate way, and to perform all those other acts which are necessary for the continuance of the animal or its species in Time and Space. In like manner the apparatus of bones and muscles—of assimilating, excreting, and secreting viscera—together with their nervous apparatus and their common action to a common end, are nothing more than evolutions, in other forms of structure and function, of the fundamental teleiotic idea, thus manifested in its most general way in the hydrozoon. These doctrines are not limited, however, to animal organisms; for it is obvious that plant-life in its simplest forms, as in the locomotive Algæ, and throughout its most complex developments, manifests itself according to the same general laws.

561. Then, again, the nutrient fluid, circulating about, rather than through, the unvascularised structures, modifies their teleiotic activity according to the varying impressions which its varying composition effects upon them. If it be defective in the appropriate elements,

whether it be air or water, the intus-suscepting and prehensional organs are put into vigorous operation; and there is manifested in the polype that teleiotic seeking after the things necessary to the maintenance of life which in higher organisms, endowed with consciousness, is termed Appetite.

562. Nor is the association of the teleorganic changes which correlate the moving, digesting, and excreting processes in these simple and apparently homogeneous tissues, different in its action from that which is seen in the association of ideas. Just as the vital processes in the polype go on to their completion when commenced by affinitive impressions, reaching the surface of the endoderm or ectoderm, so it is with the teleorganic changes excited by affinitive impressions, which correlate trains of ideas and movements, and are necessarily associated with states of consciousness (418, 419). The association of the processes in the latter case is just as necessary to the continuance of mental life, as in the former to the continuance of corporeal life.

563. This view enables us to comprehend the true character of the encephalon as the organ of mind; for we can thus look upon it as either a differentiation of a structure homologous with a like tissue present in the Hydras, yet inappreciable by the senses (for no nervous system has been discovered in them), or as the evolution of a fundamental teleiotic idea operative therein, in virtue of which there is an organ developed, with the express duty of combining the multitudinous external and internal relations of the organism into unity. Such relations must have their appropriate cerebral tissues, and hence the brain must necessarily be multiple in unity; that is, be made up of many organs of relation combined into one.

564. But from either point of view, the encephalon can only be considered as the result of a successive series of differentiations and integrations of tissues, according to that law whereby the special is developed out of the general, and the many out of the one (280, 281). Hence, while in man we have the full evolution of the organs of intellect and thought, we must look, as we descend the scale to the more simple forms, for those more strictly corporeal centres which are not yet differentiated into a system of mental organs, and of which the function is to attain all the ends aimed at in the animal instincts. But since to this end the organs and instruments of those instincts are brought into adapted relation with the external world; the materials required for the maintenance of existence into relation with the appropriate viscera; and the blood or nutrient fluid into relation with both;—we should have to determine the nerve-centres both of the animal instincts and of all those processes, as circulation, respiration, digestion, and the like, whereby the functions of the organs of vegetative life are harmonised with each other, and combined into a whole. Now, the method whereby we may arrive at this knowledge is obvious. We have to examine the order of development of those tissues and organs through which the ends of existence are attained independently of a nervous system, and determine, as far as our knowledge will permit, the laws of differentiation of function and integration of structure which are manifested in the phenomena of vegetative life, whether of animal or plant, until the complex co-ordinating apparatus of nerves and nerve-centres is evolved.

565. The anatomical composition of the cerebral hemispheres deserves special notice here, in relation to their

unifying functions. It is believed that they consist of three alternate layers of gray matter and three of white (or according to Gratiolet, four of white). In this respect they are analogous to the fundamental tissue of the polype, with its ectoderm and endoderm, and probably also to the fundamental structures of the simplest cell. It is a manifestation of the great law of relativity. The homogeneousness of structure of those layers of tissue, and the multiplicity of their functions, have also their analogies in the structure and function of the fundamental tissue of the polype. The endoderm, or alimentary membrane, appears to be as homogeneous as the cerebral tissue; yet it is certain that it performs all those varied functions which in higher animals are the functions of the glandular system of the alimentary canal, including the liver, pancreas, salivary glands, and gastro-intestinal glands proper. This homogeneousness of structure is seen alike also in the primordial cells of vertebrate animals. They physically resemble each other so closely, that there is nothing whatever by which it would be possible to say beforehand what tissues and organs would be evolved, and what form the organism would finally take. It is not, therefore, in the physical characters of tissues that we discover their vital tendencies.

566. This doctrine is true, indeed, of the properties of matter generally. We may distinguish one crystal from another by its form or its cleavage, but this gives us no true insight into the chemical affinities, and the influence on the living tissues of the chemical compound which the crystal represents. On the contrary, there are both isomorphous and isomeric compounds, which differ widely in the latter respect at least. It is clear, in short, that we can only discover the properties of matter by observing the operation of its forces; for it is through these

we attain to a cognition of matter at all. Now, this doctrine particularly applies to the cerebral hemispheres, with their diversity of function and apparent homogeneousness of structure.

567. These fundamental doctrines of a mental organology obviously include the fundamental principle of Phrenology—namely, that the brain is not only the organ of the mind, but that it is a compound organ. The objections usually raised against this doctrine are, for the most part, of a theoretical character. It is alleged, for example, that there is no traceable line of demarcation between the different portions of the hemispheres marked as special "organs" by the phrenologists, and that consequently there can be no speciality of function—a conclusion founded, as we have seen, upon a wrong method of research. So far from this being the case, we should expect the tissue which is subservient to one class of functions—*e. g.*, to the operations of intuitive ideas, to conceptions of all kinds, and to all the mental operations connected with them—to be isomorphous and homogeneous, however much the ideas might differ from one another. It would be as illogical to conclude that ideas of time and space must require a differently constituted structure, or that notions as to colours, and sounds, and forms, must each have a physically distinct organisation in the hemispheres, as to affirm that in the polype there can be no digestion, because there is no liver or pancreas; no circulation, because there is no blood; no relation to the external world or unity of action, because there is no nervous system. By the same rule, too, we might expect each primordial cell of the vertebrates to be cognisably distinct as to organisation.

568. When, however, we see a true difference in physical structure in the encephalon, we may fairly conclude

that there is a fundamental difference in functional relations. Such a difference we see between the cerebral hemispheres and the cerebellum; hence it is a reasonable conclusion that the affinities of the two are different. In this way we may even group encephalic structures together. Thus, the olivary ganglia clearly belong to the same class of structures as the hemispheres and the cerebellum, for they have their convolutions or folds; and I think we might venture even a step further, and infer that the olivary ganglia and corpus dentatum of the cerebellum belong to the same class of nerve-centres.

CHAPTER II.

HISTORICAL REVIEW OF RESEARCHES INTO THE LAW OF CEREBRAL DIFFERENTIATION WITH UNITY OF FUNCTION.

SECT. I.—*The Physiognomical Method of Research.*

569. AT a very early period of psychological inquiry the differences of mental states were recognised, and attempts were made to class them teleologically, and to allocate to each their appropriate portions of the encephalon. Thus Aristotle arranged the mental faculties proper in the three classes of judgment, imagination, and memory; and when, at the revival of letters, the Aristotelian philosophy was brought into relation with anatomy and physiology, attempts were made to develop a cerebral physiology in accordance with this classification. In the thirteenth century, Albertus Magnus divided the cranium phrenologically into three regions, so as to correspond to this arrangement: the anterior portion was allotted to the judgment or intellect, the middle to the imagination, the posterior to the memory. Petrus Montagnana published a similar chart in 1491.

570. The form of the head and face in man and vertebrates generally, and the tones of voice, gestures, play of the facial muscles, and all those phenomena which represent the internal operation of the vital forces (381), are instinctively associated with the predominant mental states which they represent; whether they be temporary,

and constitute the expression of emotions, or permanent, as indicating habits of thought and feeling (vol. i. p. 8). A sort of psychological diagnosis is thus instinctively practised by both man and lower animals, which might be termed a *faculty* of diagnosis, or Physiognosis. This mode of cognitive apperception is clearly founded upon the fundamental biotic idea of Representation (380), and, like all primary intuitive faculties, is brought into instinctive activity by its affinitive or appropriate class of impressions. The faculty of diagnosis of character is therefore, like the other fundamental faculties, not only instinctive, but an evolution of all those intuitions upon which the instinctive modes of diagnosis are founded, termed Sympathies and Antipathies. When it attains its highest development as a cognitive or intellectual faculty, it is busy with the phenomena upon which a science and art of knowing character by external form must be based. This faculty, like all others of its class, differs greatly in activity in different individuals. In some persons it is the principal guide of the feelings and conduct towards individuals, and, indeed, in all the social relations of life, to an extent of which they are hardly conscious. It operates in them with all the promptness and precision of an instinct; so that from a single word, or a change of tone, or a glance of the eye, or a slight change in the play of the features or limbs of an individual before them, they promptly draw accurate conclusions as to his feelings, motives, and intentions.

571. It follows from the doctrine already laid down as to the nature and origin of causal scientific ideas (part iv. chap. 8), and also from the doctrine of the instinctive character of all our cognitive faculties (73), that the knowledge of the mental states and powers of another individual, attained through the observation and

classification of the features in their relation to mental characteristics, is entitled to take rank amongst the sciences. Such a science is attempted in PHYSIOGNOMY; and such a science is the basis of the method by which phrenologists endeavour to determine, from his gestures, his temperament, and the form of his skull or head, both a man's mental nature, and which are the particular portions of his encephalon subservient to particular faculties. Cranioscopy is simply a branch of the science or art of Physiognomy.

572. Looked at from this point of view, we can understand how physiognomical science must necessarily be in relation to the representative arts of painting and sculpture. The artist who would excel in these, must have a quick eye to detect those forms of face and head, and that play of the muscles, which correspond to the characters that he wishes to delineate, and to the varying passions and emotions that he desires to express on canvass. Hence, it was with a just appreciation of the relations of phrenology, considered as a science of physiognomy, to Art, that Mr Combe endeavoured to specifically point out those relations.*

573. The first researches into a mental organology were made in accordance with these physiognomical intuitions. The subjoined is an example of one of these early attempts to frame a system of physiognomical organology, taken from a work on strengthening and refreshing the memory, by Ludovico Dolce, and published at Venice in 1502,. It is interesting, not merely as a physiognomical chart, but also as an example of an attempt at a psychological arrangement of the faculties. It is also instructive as clearly showing how, in the absence of all knowledge of

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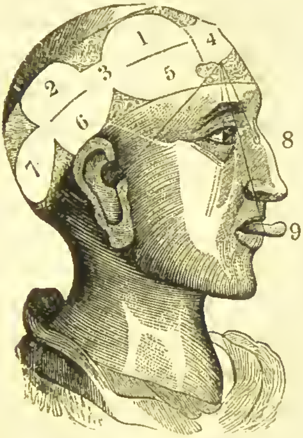
* *Phrenology applied to Painting and Sculpture.* By George Combe. 1855.

anatomy and physiology, the inquirer is wholly without a guide to clear conceptions.

Fig. 1.



REFERENCES TO FIGURE.

1 Fantasia.
2 Cogitativa.
3 Vermis.
4 Sensus Communis.*
5 Imagina.
6 Æstimativa.
7 Memorativa.
8 Olfactus.
9 Gustus.

574. It is the cranioscopical portion of phrenology, in so far as it has been applied to mental diagnosis, which has met with the most strenuous opposition; for, considered as a system of cerebral physiology, all its fundamental doctrines are admitted more or less fully by modern neurologists. It cannot be denied, that, in giving to this physiognomical element so much prominence, phrenology has passed the legitimate bounds of scientific induction; for it is certain that physiognomy being only possible as yet by means of empirical observation, it cannot attain to the dignity of a science, or rise above an art.

575. A knowledge of two fundamental but distinct laws of life and organisation is requisite to raise phrenological diagnosis to the rank of a science—namely, first, of the archetypal law of facial and cranial development in the various races of men and vertebrates generally;

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* This means the common centre of the cerebral nerves, and corresponds to the "organs" of comparison and causality.

and, secondly, of the law of modification of this archetypal law under the influence of the cerebral hemispheres and the cerebro-spinal centres, which are active in the instincts and emotions. The physiognomy of an individual, whether cranial or facial, is probably never the result of either one or the other solely; nay, it is equally probable that it expresses the ancestral influence of modes of thought, as well as those of the influence of the individual himself (426, 427).

576. Great skill may however be attained by persons specially endowed (as the majority of practical phrenologists are) with the faculty of physiognomical diagnosis; and experience may develop its fundamental intuitions into an art. Hence, in the practice of physiognomy generally, and of its subdivisions of cranioscopy, cheiromancy, and graphiology, the results of observation are sometimes so striking as to present all the apparent certitude of a science. Such results, however, are wholly due, like all other empirical results in art, to the skill of the artist, enhanced very often by a knowledge of principles derived from experience.*

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* Although I thus dissent from the physiognomical method of phrenology, considered as a sufficient method of inquiry, and from its physiognomical doctrines, considered as a science, I wish by no means to deny the diagnosis of and value of observations of the forms of the head and face in reference to the mental character. They are essential to a solid foundation of a true science of physiognomy. And when the principles of cranial and facial morphology are sufficiently developed, so as to allow of the arrangement of physiognomical and cranioscopical observations scientifically, the collections of skulls and casts of the head and face made by phrenologists will be found of great advantage to mental science. Considered from this point of view, the collection of the Phrenological Society of Edinburgh is well worthy a place in the Museum of Natural History of the University. Nor should it be forgotten, that when so placed it would probably induce some of the many

SECT. II.—*The Anatomical Method.*

577. The physiognomical method may be carried on independently of anatomy and physiology; hence it has always been the most popular method of inquiry. But when once the brain was acknowledged to be the organ of the mental faculties, just as the stomach is the organ and seat of the process of digestion, the usual method of physiological research was applied to the determination of its functions. Now it was so acknowledged long anterior to the Christian era; indeed, the doctrine was (as it is now) part of the popular belief. But when inquirers thus turned their attention to cerebral physiology, they recognised, without exception, the psychological principle of a multiplicity of faculties and powers, and could not, therefore, do otherwise than adopt the correlative physiological doctrine. Hence anatomists and physiologists in general, from Willis downwards, have asserted the principle of multiplicity of cerebral structures as organs of mental powers, or seats of mental states.

578. Willis is, without doubt, the father of modern cerebral physiology. He made careful dissections of the brain, with a view to determine the seat of the various faculties, or, in his own words, the particular "canals" or "passages" through which the "animal spirits" pass when various mental states are induced or manifested.

students in medicine who go to the distant colonies of the empire, or serve with our fleets and armies *per mare et terras*, to add to the collection by contributing skulls or casts of heads and faces illustrative of the various races of mankind scattered over the earth. It would thus form the nucleus of an ethnological collection, without which, considered simply as an illustration of the Natural History of Man, no museum of natural history can be allowed to be complete.

His dissections and engravings of the brain are interesting even now; for in some respects he taught doctrines similar to, and even in advance of, those of modern physiologists. He made the *corpora striata* the seat of consciousness, in connection with doctrines as to diversity of function of other portions of the encephalon. "As to the offices and uses of the *corpora striata*, though we can discern nothing with our eyes, or handle with our hands, of those things that are done within the secret conclave or closet of the brain, yet by the effects, and by *comparing* rationally the *faculties* and acts *with the workmanship of the machine*, we may at least conjecture what sort of works of the animal function are performed in these or those, or within some other parts of the head; especially because it plainly appears that the offices of the interior motions and senses, as well as of the exterior, are acted by the help of the animal spirits ordained within certain and distinct paths, or as it were small little pipes."*

579. Willis' researches were instituted in relation to the current theory of the animal spirits (subsequently replaced by the "nervous fluid" and *vis nervosa*), as the efficient agents of sensation, motion, and thought, and which were said to be generated in the ventricles. This was the doctrine of Galen, and held its ground until the commencement of the eighteenth century. In accordance with this theory, the Arabian writers, following Galen, fixed upon the ventricles of the brain as the special seat of the mental faculties; one of the anterior ventricles they made the seat of common sensation; the other, of the

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* *Two Discourses concerning the Soul of Brutes, which is that of the Vital and Sensitive of Man*, by Thomas Willis, Doctor in Physick, Professor of Natural Philosophy in Oxford, &c.; Englished by S. Pordage, Student in Physick, folio (1683), p. 27.

imaginative faculty; the third ventricle was the seat of understanding, and the fourth of memory. These doctrines were also maintained by Duns Scotus, Thomas Aquinas, and other philosophers as late as Descartes; Caspar Bauhin was the first to question them, and to maintain that the "animal spirits" were generated in the substance of the brain, and distributed directly from thence through the nerves to the organs of sensation and motion. Platner, Varol, Spiegel, Caspar, Hoffmann, and others, also opposed the ventricular theory of localisation; but especially Hoffmann, who in consequence drew down upon him the anathemas of those who supported the ancient theories. He was particularly charged by Riolan the younger with ignorance, and with unsettling, by his new dogma, both the entire pathology and therapeutics of the brain; for he actually had the temerity to fix the seat of epilepsy and apoplexy in the substance of the brain, and not in the ventricles, as Galen taught. "And this is the argument," Prochaska remarks (from whom I have taken the preceding facts), "with which physicians are accustomed to meet new dogmas when opposed to their own, even if true; lest they should be compelled by shame to unlearn, when old, those theories which they have learnt in youth. Harvey was met with almost a similar argument, and considered as an audacious man."*

580. It was after the "animal spirits" were ejected from the ventricles that Malpighi, Sylvius, and Willis attempted to show that they were secreted by the cortical substance, whence they were received by the medul-

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* *The Principles of Physiology*, by J. A. Unzer, and a *Dissertation on the Functions of the Nervous System*, by George Prochaska: translated and edited for the Sydenham Society by Thomas Laycock, M.D., &c., &c. (1851), p. 371.

lary substance, to be transmitted by it to the nerves of the whole body. To these, therefore, is due, and of these more especially to Willis, the first indication of the established doctrine of modern physiology, and which Gall and Spurzheim more fully developed—namely, that the cortical part of the brain, or the cineritious neurine, is ganglionic, or the seat of *action* or energy; and that the medullary or fibrous is a conducting structure, analogous to the trunks of the nerves. Willis retained some of the other Galenical doctrines; but he peculiarly maintained that the cerebrum subserves to the animal functions and the voluntary motions, the cerebellum to the involuntary; that a perception of all the sensations takes place in the ascending fibres of the *corpora striata*, and that through the descending fibres voluntary movements are excited; that the understanding and imagination have their seat in the *corpus callosum*, and the memory in the convolutions, which are its "storehouses."

581. A host of physiologists supported or opposed the doctrines of Willis; but amidst the innumerable controversies which arose, the doctrine of mental organology, or of cerebral differentiation of structure, with specialisation of function, continually advanced. In 1784 Prochaska summarised the views of previous inquirers generally, and indicated the advance which the doctrine had reached at this period, when Gall began his researches and teaching. He concludes his review with these remarkable and memorable words: "At length we abandon the Cartesian method of philosophising in this part of animal physics also, and adopt the Newtonian; being persuaded that the way to truth through hypotheses and conjectures is tedious and altogether uncertain, but far more certain, more excellent, and shorter, through the

inductive method."* The whole theory of "animal spirits," hitherto held sacred, is then in few words finally discarded.

582. In proceeding to discuss the functions of the brain, Prochaska did not omit the question of multiplicity of "organs." "Hitherto," he says, "it has not been possible to determine what portions of the cerebrum or cerebellum are specially subservient to this or that faculty of mind. The conjectures by which eminent men have attempted to determine these are extremely improbable; and that department of physiology is as obscure now as ever it was; and we think, with Haller, that no light can be thrown upon it in any other way than by a careful dissection of the brains of fatuous persons, apoplectics, and such as have other disorders of the understanding."†

583. Here is no mention made of physiognomical research such as Gall was already practising; but how near Prochaska came in other respects to the doctrines of Gall may be easily shown. The third section of the fifth chapter of Prochaska's *Dissertation* (1784) is headed, "Do each of the divisions of the intellect occupy a separate portion of the brain?" In answer to this oft-proposed problem, Prochaska proceeds thus: "It is our consciousness, and a certain peculiar feeling, which convinces every one that he thinks with his brain. But since the brain, as well as the cerebellum, is composed of many parts variously figured, it is probable that nature, which never works in vain, has destined those parts to various uses, so that the various faculties of the mind seem to require different portions of the cerebrum and cerebellum for their production. Since, however, the *sensorium com-*

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* *Op. cit.* p. 380 (the author's translation).

† *Ibid.* p. 446.

mune reflects the sensorial impressions into motor by definite laws peculiar to itself, and independently of consciousness, and since we have laid down that the *sensorium commune* comprises the *medulla oblongata*, *medulla spinalis*, and the origin of all the nerves, it follows that the cerebrum and cerebellum, together with their connections, the *sensorium commune* excepted, constitute the organs of the faculty of thought; and as in some animals these are entirely wanting, it is fair to conjecture that the faculty of thought is also wanting, and that they exist only in virtue of the *vis nervosa* of the *sensorium commune*, and of the nerves with which they are endowed." Prochaska thus eliminated the hemispheres, the *corpus callosum* and the cerebellum, from those portions of the encephalon which he allotted to the sensorium—namely, the ganglionic centres of the cerebral nerves, the *crura*, and the *medulla oblongata*—and constituted them the organs of mind.

584. Now, while Haller, Metzger, Prochaska, and others, were thus seeking to determine cerebral organology by anatomical and pathological research, Lavater was engaged in his physiognomical inquiries. That great observer (whose observations will yet some day be made available by science) published his *Physiognomic Fragments* in 1775. This work excited an immediate and very general interest in physiognomical research, and could hardly fail to attract the attention of Gall: the more especially as Lavater laboured most strenuously in collecting silhouettes and portraits from all quarters, and in generalising his observations, with the hope of raising physiognomy to the rank of a science. He necessarily failed in this attempt, for the reasons already stated; but he achieved a high position as a physiognomical artist, and this success might well stimulate

the ambition of Gall, who was evidently as specially endowed with the faculty of diagnosis of character as Lavater himself.

585. That Gall did not finally pursue tho physiognomical method exclusively, was due partly to the spirit of the age, partly to his training in medical science. The scientific spirit of the age was singularly favourable to the line of research that he took up. The middle and close of the eighteenth century, until the outbreak of the French Revolution, was a period remarkable for the culture and development of neurology and physiological metaphysics. Stahl had given the latter a great impulse by his revival of the Aristotelian doctrine of the *Psyche*, and his application of it to the phenomena of healthy and morbid action, and the treatment of disease (vol. i. p. 44). After the promulgation of the Stahlian doctrines, neurological anatomy and physiology were widely cultivated, especially in Germany. During the period named, Pfeffinger, Haase, Lobstein, Metzger, Soëmmering, Meckel, Hirsch, Wrisberg, Boehmer, Asch, Bang, Andersch, Murray, Bose, Platner, Brunn, Heineken, Behrends, Ludwig, Ebel, Isenflamm, Thaer, Ploucquet, Baur, Zinn, and others, investigated the anatomy, physiology, and pathology of the nervous system, some of whom have left their names connected with their discoveries.* Very distinguished systematic writers also flourished during this period, as Albinus, Winslow, Vicussens, Haller, Bonnet, Unzer, Prochaska, Vicq d'Azyr, and others.

586. Gall pursued his medical studies in the midst of all this struggle after a knowledge of the anatomy and physiology of the nervous system; for being born in

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* *Scriptores Neurologici Minores Selecti, &c.*, edidit. Chris. Fred. Ludwig, tom. iv. Lipsiæ, 1795.

1757, he would probably be at the university of Vienna about 1777. Influenced by Lavater's researches, his first attempts at observation were purely physiognomical. He found himself excelled in powers of memory of words by fellow-students and schoolmates who had prominent eyes. After much reflection, he conceived that if a memory for words was indicated by an external sign, the same might be the case with the other intellectual powers; and thereafter all persons distinguished by any one faculty became the object of his attention. Thus he became acquainted with individuals remarkable for the determination of their character, and he observed a particular part of their heads to be very largely developed. This fact suggested to him the idea of looking to the head for signs of the dispositions or affections. Gall at first, therefore, endeavoured to establish a cranial physiognomy, and in this respect was a follower of Lavater: it was only after a more extended study that he was convinced of the need to investigate the anatomy and physiology of the brain. In his great work, he significantly remarks, as to the value of cranioscopy,—"Jamais je n'ai pretendu distinguer des modifications peu prononcées des formes du crâne, ou de légères nuances du caractère."*

587. Such, then, was the state of physiological psychology when Gall first attempted to allocate portions of the hemispheres to special faculties. But in doing this both Gall and Spurzheim limited the term *medulla oblongata* to that portion of the central axis, which extends from the lower border of the *pons Varolii* to the occipital foramen, and thus deviated from the anatomical definitions of their predecessors—for Prochaska was not alone in his doctrines. Long previously Willis had stated,

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* *Sur les Functions du Cerveau*, tom. iii. p. 41.

"Where the *corpus callosum* is thought to end, there the *medulla oblongata* begins;" and he anatomically describes it accordingly. All the successors of Willis used the term *medulla oblongata* more or less in a similar sense. Hence the older writers marked three great divisions of the encephalon—the cerebrum, brain, or hemispheres, including their commissure, the *corpus callosum;* the cerebellum or little brain, with its crura, and the head of the spinal column; and the *medulla oblongata*, or oblong medulla, including from the *corpora striata* downward. The *medulla spinalis* and *oblongata* were also termed the *cerebrum prolongatum*, the *prolonged* brain,—the theory being, that this portion of the central axis arose, or was prolonged from, the cerebrum. Now the *medulla oblongata*, thus defined, was considered to be the point of origin of the encephalic nerves, and (through its continuation into the spinal cord) of all the nerves of the body. In this way it came to be considered the seat of sensation (the *sensorium commune*—the common centre of consciousness), or point of union between the sensory nerves on the one side, and the hemispheres on the other. This doctrine disappeared almost wholly with the advance of Gall's views, and the ganglia constituting that portion of the *medulla oblongata* situated above the *pons Varolii* were considered to be part of the brain or cerebrum. It is only within the last few years that Dr Carpenter has revived this portion of the doctrine as a new theory, giving the name "sensory ganglia" to these structures, instead of *sensorium commune.*

588. With this explanation we can better understand Prochaska's conclusions as to a plurality of organs of the mental faculties.* "It is therefore by no means improbable," he remarks, "that each division of the intel-

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* *Op. et loc. cit.*

lect has its allotted organ in the brain [or hemispheres], so that there is one for the perceptions, another for the understanding, probably others also for the will, and imagination, and memory, which act wonderfully in concert, and materially excite each other to action. The organ of the imagination, however, amongst the rest, will be far apart, I should think, from the organ of perceptions, since, the organ of perceptions being asleep and at rest, the organ of the imagination may be in action, a condition which produces dreams;" an argument identical with that brought forward in support of the doctrine by modern phrenologists.

589. It thus appears, therefore, that when Gall promulgated his views, the doctrine of plurality of mental organs was one which had been universally admitted since the time of Galen. The only questions that arose were as to the portions of the encephalon to be allotted to each; theologians, philosophers, schoolmen, physicians, anatomists, physiologists, all adopted without question the general principle. Mr Combe is completely justified, therefore, in his conclusion, "that the presumptions are all in favour of a plurality of mental faculties manifesting themselves by a plurality of organs."*

590. In more modern times, some of our best psychological physiologists have adopted this doctrine of multiplicity of parts in the cerebral tissue, although they are by no means of the phrenological school. "The phrenologists rightly regard it as probable," Sir H. Holland remarks, "or even as proved, that there is a certain plurality of parts in the total structure of the brain, corresponding to, and having connection with, the different intellectual and moral faculties. The undoubted natural diversity of these faculties makes this probable, seeing

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* *System of Phrenology*, 5th edit. vol. i. p. 3.

that we must regard a certain organisation as ministering in the present life even to the higher powers of our nature. The partial and varying effects of accident, disease, or other less obvious change in the brain, in producing derangement of the mental functions, furnish more direct evidence, and such as we cannot refuse to admit."* And we have equally strong testimony from Mr Herbert Spencer, one of the most profound thinkers of the day :—"No physiologist, who calmly considers the question in connection with the general truths of this science, can long resist the conviction that different parts of the cerebrum subserve different kinds of mental action. Localisation of function is the law of all organisation whatever; separateness of duty is universally accompanied with separateness of structure; and it would be marvellous were an exception to exist in the cerebral hemispheres. Let it be granted that the cerebral hemispheres are the seat of the higher psychical activities; let it be granted that among those higher psychical activities there are distinctions of kind, which, though not definite, are yet practically recognisable; and it cannot be denied, without going in direct opposition to established physiological principles, that these more or less distinct kinds of psychical activity must be carried on in more or less distinct parts of the cerebral hemispheres. To question this, is not only to ignore the truths of physiology as a whole, but especially those of the physiology of the nervous system." Mr Spencer further adds, —"Either there is some arrangement, some organisation in the cerebrum, or there is none. If there is no organisation, the cerebrum is a chaotic mass of fibres incapable of performing any orderly action. If there is some organisation, it must consist in that same physiological division of labour in which all organisation consists; and there is no division of labour, physiological or other, of which we have any example, or can form any conception, but what involves the concentration of special kinds of activity in special places."*

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* *Chapters on Mental Physiology*, 8vo (1855), chap. ix.

591. The phrenological school have had to carry on an incessant war in defence of their doctrines, but more especially of the physiognomical portion, which are the most vulnerable. I need only notice here the controversies which have arisen out of the doctrine of multiplicity of organs and diversity of function. These have originated in one fundamental defect—namely, the omission to recognise that law of unity in multiplicity, and of multiplicity in unity, which is the fundamental law of both mental and vital processes alike. Neither side, in short, brought that philosophical principle to bear on the question which Mr Spencer points out. One instance will suffice to show this is true as to one side. Dr Carpenter is one of those who oppose the doctrine of differentiation of the hemispheres; and yet, while opposing it, he cannot but acknowledge the teachings of physiognomical experience regarding it. In discussing the doctrine, he remarks that it is "a fundamental error to suppose that the entire intellect can be *split-up* into a certain number of faculties; for each faculty that is distinguished by the psychologist expresses nothing else than a *mode of activity*, in which the whole power of the mind is engaged at once,—just as the whole power of the locomotive steam-engine may be employed in carrying it forwards and backwards, according to the direction given to its action; and if this be true, it must be fundamentally erroneous to attempt to parcel out the cerebrum [the cerebral hemispheres] into distinct 'organs' for these respective faculties; the whole

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* *Principles of Psychology* (1855), p. 607.

of it (so far as we [Dr Carpenter] can form a judgment) being called into operation in every kind of mental activity."* The analogy drawn between the human mind and a steam-engine is rather too wide to help in the elucidation of an argument, and need not be examined, the more especially because Dr Carpenter elsewhere expresses other and sounder views on this point. After noting the correspondence between the development of the brain, and the manifestations of intelligence in lower animals, and specially, "the very decided evidence furnished by the great enlargement of the cerebrum [the hemispheres], and the corresponding alteration in the *form* of the cranium, which present themselves in those races of dogs more distinguished for their educability," Dr Carpenter adds, "This general inference, drawn from comparative anatomy, is borne out by observation of the human species. When the cerebrum [cerebral hemispheres] is fully developed, it offers innumerable diversities of form and size among various individuals; *and there are as many diversities of character.* It may be doubted if two individuals were ever exactly alike in this respect."†

592. In this exposition of his views Dr Carpenter evidently means to say, that the hemispheres of the brain of man and the higher vertebrates present as many diversities in form and size as there are diversities of individual character: this is granted; but phrenologists say no more. They, however, proceed to observe carefully the two series of facts, to compare them, and to draw deductions as to how far the form and size of the cranium coincide with the form of the brain, and consequently with the character. Now, Dr Carpenter fails even to attempt this; he offers no explanation of the facts; nor,

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* *Human Physiology*, 5th edition, pp. 598, 599.

† *Op. cit.*, pp. 541–42.

in truth, does more than meet the efforts of those who do attempt the inquiry by a legitimate method of research, with objections too hazy and pointless to be of any scientific value.

593. The proposition that the whole power, or *vis viva*, of the body (not of the abstract thing, Mind), is engaged in each concentrated act of energy, cannot, I think, be controverted; nor is it improbable, that even the whole of the nervous system is engaged in certain operations of the faculties. If, for example, one portion of the brain undergoes such a morbid change, that its vital reactivities correlate a "fixed idea," which dominates over the whole thoughts of the man, then a small portion of the encephalic tissue so affected will draw the whole into activity, according to its own special mode. In like manner, intense pain in any part of the body, or intense feeling from any cause, will involve all the faculties and powers. Take, for example, the feelings which are caused, when nutriment, water, or oxygen are not present in sufficient quantity in the blood and lungs, so that thirst, and the desire for air, are excited. All will agree that the seat of these feelings is not the hemispheres, however differently they may theorise as to the portion of the encephalon that should be allotted to them; for it is probable that they are experienced by animals, as the invertebrata, in which there is no reason for concluding that hemispheres exist at all. Yet, if these appetites be intensely developed, every faculty of the animal or the man is concentrated upon the acquisition of food or drink, or air, as the case may be, to the exclusion of all other objects whatever. Such illustrations might be multiplied to any extent; but more are not needed, as two opinions will be hardly held on the subject. We may certainly conclude, then, that

a change in one limited portion of the encephalon will involve the whole.

594. But all this only shows that in the encephalon of man, as in the body of a hydra, apparent homogeneousness of structure is entirely compatible with differentiation of function and of unity of action and relations with both. The phenomena in question are simply manifestations of the fundamental law of all life and thought—the Many in the One, and the One in the Many.

CHAPTER III.

PRINCIPLES OF A PHYSIOLOGICAL CLASSIFICATION OF VITAL AND MENTAL PHENOMENA IN CORRELATION.

595. It still remains for us, before proceeding to examine more particularly the fundamental modes of vital activity, and the correlations of mental and vital processes, to mark out a plan of procedure, whereby we may pass from the more general to the more special in all correlations of life and consciousness. For we have to bear in mind that it is not only mere vital processes that we have to examine, as they are evolved in tissues already constructed; we have also to consider what are the laws of construction, growth, and nutrition, by which the tissues themselves are evolved (413, 446). The only plan by which we can sufficiently indicate the various steps of a suitable method of inquiry, is to establish a physiological classification of mental phenomena on the basis of the fundamental idea of Life and Mind,—the evolution of the general into the special—of the One into the Many.

596. It is well known to metaphysicians that nothing has been found more difficult than the classification of mental phenomena which a systematic Psychology demands, except the classification of vital phenomena which a philosophic Zoology demands; and nothing is more conclusive as to the need of fundamental principles

in both departments of human knowledge than the contradictory classifications they afford. These discrepancies and difficulties may, I think, be traced to that radical error, in both metaphysics and biology, by which the progress of a practical science of mind has been so hindered, and which we have already so fully discussed—namely, the entire separation of the two classes of phenomena.

597. The psychologists, neglecting that most fundamental principle of all inquiry into the laws of consciousness, that the laws of Life and Thought are correlative, have omitted phenomena, the comparison and classification of which were necessary to sufficient generalisations and deductions. When a man "retires into the depths of his own consciousness," and draws exclusively from thence the phenomena he compares and classifies, how can he possibly observe, compare, and know anything of those mental processes, or any portion of them, of which he is not conscious? If he considers the human mind to be a thing absolutely isolated, and wholly separate from mind as manifested in creation, how can he derive any light as to the nature and workings of that mind from a comparison and classification of the phenomena of mind as displayed in creation? The result of those limited views may be readily traced in the defects of current classifications. They include conscious mental operations only, whereas, if the doctrine I have advocated be true, they should include the unconscious also; they are limited to the operations of the human mind, whereas they should comprehend, if my views be correct, psychal phenomena, as manifested in all other organisms; they take no note of the coincident corporeal changes, whereas these changes, as the exponents of mind in action, should be their principal objects. In other words, the psychological phenomena must be

classed in correlation with the phenomena of development, structure, and function (446).

598. There is, however, a formidable obstacle to be considered, even if the right method be adopted. Let it be granted that we must include within our classifications all the phenomena of life as manifestations of mind, a difficulty arises at the outset in the fact that they are all continuous, both in co-existence and succession. Hence, whether we consider living things as a whole, or whether we take man as the sum and crown of created beings, we cannot draw lines amidst the phenomena of life and consciousness, and say, Here is vegetative life, there is animal; here is sensation, there no sensation; here instinct, there reason. This is the great law of continuity of phenomena, of which Aristotle and Leibnitz are amongst the greatest teachers, and which Bonnet and Blainville have in modern times applied to practical inquiries. It is a principle which not a few thinkers and observers have maintained, whether poets, philosophers, metaphysicians, or naturalists.* "It is not more certain," Mr Spencer observes, "that from the simple reflex action by which the infant sucks, up to the elaborate reasonings of the adult man, the progress is by daily infinitesimal steps, than it is certain that between the automatic actions of the lowest creatures and the highest conscious actions of the human race, a series of actions displayed by the various tribes of the animal kingdom may be so placed as to render it impossible to say of any one step in the series, Here intelligence begins."†

599. This multitude of continuous events is associated

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* Compare Pope's "See through this air," &c., *Essay on Man*, Ep. I. § 8; and Soame Jenyns "On the Chain of Universal Being."

† H. Spencer, *Prin. of Psychology*, p. 349.

with another law—the law of complexity in continuity. Every vital event is in relation with co-existent as well as with antecedent and successional events (150). It follows, therefore, that there are collateral as well as linear relations to examine; and instead of a line before the mind's eye, there is a solid, either cube or sphere.

600. Now, the difficulties in the way of a satisfactory classification of organisms, to which this continuousness and complexity of vital phenomena have given rise, have been constantly experienced by zoologists and botanists from the time of Aristotle. They have been more particularly felt, partly from the circumstance that mere form has been selected as the starting-point for a comparison of organisms and the deduction of likenesses and differences; partly because the theory of archetypes has been imperfectly developed and applied. Thus the idea of successional evolution in time and space of created things, so true in itself, has been believed to be too simply linear. In that form it has been applied to the archetypal development of organisms, and a linear organismic scale of ascending development has been shadowed forth. According to this view, there is not only every grade of development of animal life from below upwards, and all capable of classification into species, genera, orders, but each individual of the higher grades is supposed to pass in development through all the phases characteristic of the lower. All this is now, however, much questioned; and it seems more probable that there are types, or branches of successional development, which radiate rather from a common circle or centre than spring from a common stem.*

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* No Vertebrate is, or resembles at any time, an Articulate; no Articulate, a Mollusk; no Mollusk, a Radiate; and *vice versa.* Whatever correlations between the young of higher animals and

601. If I might venture an opinion, I would say that the true law seems to be this: there are certain fixed functions to be performed, or, in other words, certain ends to be attained according to a comprehensive plan; but the means and modes by or according to which the plan may be carried out are not fixed; on the contrary, they are necessarily variable and contingent (250). Hence, while we can classify the ends and functions with comparatively little difficulty, the endless complexity of organisation and variety of form, which are seen as we ascend from the general to the special, baffle the best attempts at zoological arrangement. If we take in plant-organisms, and all their remarkable analogies with animals as to structure and function, we certainly avoid the difficulty which is experienced in distinguishing between the simpler forms of animal and plant life, but we add enormously to the number of phenomena to be classed. Under any other principle than that of the teleological law just laid down, a general classification of all vital phenomena whatever, would, in fact, be impossible.*

602. Professor Owen has given a definition of organisms which has a philosophical idea as its basis: "Organisms, or living things, are those which possess such an

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the perfect condition of inferior ones may be traced, they are always limited to representatives of the same branch. For instance, Mammalia and Birds, in their earlier development, exhibit certain features of the lower classes of Vertebrates, such as Reptiles or Fishes; Insects recall the Worm in some of their earlier stages of growth, &c.: but even this statement requires qualification."—M. Agassiz, *Essay on Classification*, p. 207.

* Compare, *inter alia*, as to the general resemblances in structure and function of the lower forms of plants and animals, Professor Owen, *Lectures on Invertebrate Animals*, 2d edit., p. 2, *sqq.*; Agassiz, *Essay on Classification*, p. 290; Quekett, *Lectures on Histology*, p. 3. As to the difficulties in determining the species of plants, compare Rev. M. J. Berkeley, *Introduction to Cryptogamic Botany*.

internal cellular or cellulo-vascular structure as can receive fluid from without, alter its nature, and add it to the alterative structure. .Such fluid matter is called 'nutritive,' and the actions which make it so are called 'assimilation,' and intus-susception.' These actions are called 'vital,' because, as long as they are continued, the 'organism' is said to 'live.' When the organism can also move, receive the nutritive matter by a mouth into the stomach, inhale oxygen and exhale carbonic acid, and develop tissues the proximate principles of which are quaternary compounds of carbon, hydrogen, oxygen, and nitrogen, it is called an 'animal.' When the organism is rooted, has no mouth or stomach, exhales oxygen, has tissues composed of 'cellulose,' or of binary or ternary compounds, it is called a 'plant.' But the two divisions of organisms called 'plants' and 'animals' are specialised members of the great natural group of living things; and there are numerous organisms, mostly of minute size, and retaining the form of nucleated cells, which manifest the common organic characters, but without the distinctive superadditions of true plants or animals. Such organisms are called *Protozoa*."*

603. It may be said, briefly, that the alimentary organs of prehension of plants—namely, the mechanism for supplying nutrient elements—are in the ground in immediate contact with their food, while their lungs (the leaves) are equally in immediate contact with the air. On the contrary, animals have their alimentary apparatus or stomachs contained in a cavity, with which organs appropriate for the prehension of aliment are connected; and their aërating apparatus are either situate externally, or placed in a cavity with its appropriate organs for the intus-susception of air or aërated water:

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* "Palæontology," *Ency. Britan.*, vol. xvii. p. 91.

whether that contains oxygen as the proper ingredient, or carbonic acid, is a secondary question; the end aimed at is attained, under proper conditions, by air containing either or both.

604. But although plants are usually fixed to the soil, some are locomotive like animals; such are the Algæ, which may be termed animals that aliment and aërate like plants. On the other hand, animals may be composite and fixed like plants; such are certain forms of Zoophytes. The cænosarc, or common stem of a group of the Hydrozoa, presents various plant-like forms. Thus, in the Corynidæ and Sertulariadæ it presents almost as many diversities in form and habit as the branching stem of a plant. It may be slender and creeping, or twining; or it may simulate a tree with stout erect trunk. But these variations in structure are simply due to varieties in the modes in which the same fundamental ideas are carried out. They all only serve to prove the unity of plan and the identity of teleiotic ideas according to which organisms live and energize.

605. It is clear, therefore, from these considerations, that every arrangement of the phenomena of life and organisation, to be complete, must have an idealistic basis, since it must be founded upon the modes in which organisms manifest the operation of causal or teleiotic ideas (446). Doubtless, the morphology of organs or the development of structures may serve the purpose; but since the same end is attained by an infinite diversity of structures and forms, it is plain that no arrangement can be complete if based upon so variable a class of phenomena. It is only the teleiotic idea, which, being permanent, absolute, and universal, is sufficient for an arrangement which shall include both plant and animal organisms, and generalise the innumerable facts and ob-

servations upon which the ever-increasing naturalists' species and varieties are based.

606. This doctrine, although not formularised by Mr Darwin* and others, is virtually the foundation of their views as to the development of species. For, inasmuch as species are determined from morphological characters, and these depend upon the relations which the organism bears to external conditions, it is manifest that a theory which derives changes in form from the continual adaptation of organisms to the varying conditions in which they are placed, is wholly teleological. As to the fundamental idea of adaptation to ends, the theory of Lamarck, of the author of the *Vestiges of the Natural History of Creation*, and the more modern doctrines just referred to, are alike, for it is the common basis of them all. The differences in doctrine are as to the modes in which that adaptation arises and is carried on.

607. These considerations, taken in connection with what has been already set forth as to the right method (vol. i. p. 216) to be followed in developing a mental science on a teleological basis, will suffice to show what principles are to be followed in examining the relations of vital phenomena to each other, and how they may be most usefully classed. This, at least, is obvious, that a more philosophical and more systematic application of the principles of teleology to biological science is imperatively demanded, if we would have clear conceptions of structure and function. Now, since both structure is built up and function exercised with a view to fundamental ends—and as these ends, considered as derivatives of the universal law of design, have been termed teleiotic ideas (162)—I shall apply the term *teleiotic homology* to the results of the method of examining into

* *On the Origin of Species by Means of Natural Selection.* 1859.

the structures of organisms which I now recommend, and which, fixing definitely upon a primary teleiotic idea or law of development, examines them not only *per se*, but as constructed according to that law, in relation to each other, as parts of a harmonious whole—and in relation to their functions, as the organs or instruments of that whole. Such a method of determining homologies, based as regards the mere development of organisms and their leading structures upon an archetypal idea, will go beyond that gross morphology to which it has been hitherto too much restricted; and, by tracing the fundamental teleiotic ideas contained in the archetypal idea through their subordinate manifestations in structure, and through the various processes of differentiation and integration to which they are subject, attain to a knowledge of the complex organs and tissues not attainable by any known means of research. In like manner, as to the function of organs, constructed according to a teleiotic idea — they energize according to the same idea. Hence a classification of ideas (that is, of ends aimed at and attained) will correspond to classification of functions based on a teleiotic anatomy of the parts which make up the organism; or, in other words, both structure and function must be classed according to an arrangement of teleiotic ideas.

608. A classification like this need not present insuperable difficulties, for we have already established two fixed general principles of life and organisation—namely, *first*, That there are known and absolute general causal ideas; *secondly*, That these ideas are evolved into their subordinate or derivative ideas according to a fixed law of evolution or succession, and inter-connection. All that we need do, therefore, is to take one or more of these general ideas, and compare their evolution and inter-connection in pheno-

mena (*i.e.*, in their effects) with their logical inter-connection and sequence in thought. By the one method we can classify phenomena *à posteriori;* by the other *à priori*, and so be enabled to compare them: the result will be a true classification founded on each, with the errors mutually eliminated. We thus, on the one hand, examine the operations of the ideas as causes, and on the other arrange their results as manifested in structure and function; for we have to inquire into both what they do, and how they do it. This circumstance renders it necessary that we should have the clearest conceptions possible of the nature and origin of those causes termed teleiotic ideas; and more especially of their true relation to their leading phenomena—viz., on the one hand to energy without consciousness, and on the other to energy with consciousness. The former is the class of vital objective phenomena, the vital proper—the latter the class of vital subjective, the mental proper. Neither can be understood, in their relations to each other, as equally the results of vital action according to *biotic* laws, unless the common causes of both be clearly conceived, and the order of the resulting phenomena be demonstrated in both their co-existences and successions; for it is in virtue of the teleorganic changes occurring without consciousness that we become conscious at all, and thereby are enabled to know.

609. Such, then, are the foundations of a true mental physiology, and such the mode of its development. It must strike its roots deeply into the first causes of life and organisation, and be evolved from a few fundamental stems into a spreading tree of knowledge, of which the innumerable branches are loaded with leaves, and flowers, and fruit, for the solace and happiness of mankind.

CHAPTER IV.

OUTLINES OF A CLASSIFICATION OF CORRELATIVE MENTAL AND VITAL PHENOMENA.

Sect. I.—*Primordial Modes of Vital and Mental Energy.*

610. Proceeding to the application of these principles to a sketch of the general outlines of a classification of mental phenomena, let us select the most fundamental of the teleiotic ideas, and consider its operation as a mode of vital energy (279). Such an energy is that which adapts the transference of force (137) to vital function; or, in other words, regulates the application of the physical forces of nature to the ends manifested in life and organisation—that is, to the phenomenal evolution of subordinate ideas (414). Now, two things are requisite for this purpose—the forces themselves, and the substratum in which they operate (313). Consequently, the first vital process of an organism is the reception of these forces—namely, heat, light, and the like—into the material substratum constituted of teleorganic matter (323), in and upon which they can act according to the laws of life.

611. The largest amount of that force which is available to the ends of organisms is contained in aerial or gaseous matter; consequently the atmosphere may be considered as the principal source of vital force, or of what may be termed Dynamic nutrition. But the forces

of matter are contained in all the nutrient elements, out of which the substratum is formed, as so-called latent forces, as well as in gaseous matter; while the sun is the direct source of force, as both light and heat. The primordial energies, therefore, of an organism are those which aim at the acquisition of two things—matter and its forces. And under matter we comprise all that serves to alimentation, including air; and whether it be to secure its carbonic acid or its oxygen; and whether the two latter be contained in earth, air, or water. But matter and its forces are only sought and utilised to ends. Now, these ends are comprised in the fundamental ideas of organic life; namely, the continuance of the individual and of the species in Time and Space. This dichotomises into two ideas: 1. The maintenance of the life of the individual until its end be fulfilled—namely, reproduction; 2. The reproduction of new individuals in Time and Space. Out of these primary energies we can evolve a whole series of modes of activity, whether of animals or plants, with their appropriate organs, and develop teleiotic homologies of structure in relation to teleiotic function. These modes of energy are termed Instincts (279), and their organs are the organs of the Instincts.

612. The consideration of teleiotic ideas cannot be arrested, however, at this point; for the great question arises, For what ends do the individuals and species exist? Put in this form, it is that great question of the ends of creation upon which so many hypotheses and speculations, metaphysical, teleological, and theological, have been expended in vain. Now, it is only as to one kind of organism that man is in a position to determine the ends of its creation, and that is his own. In his fundamental intuitions and desires, when rightly interpreted, as we have seen, man has given to him the evidence of

the ends of his existence in time and space (146). These are, briefly, that he may acquire such a knowledge of the cause and order of creation as is possible with his present faculties, and thereby attain to a knowledge of the Good, and the Beautiful, and the True. Or, in other words, all his instincts proper (or corporeal instincts) are but the necessary antecedents and foundations of his moral instincts. Considered from this point of view, the moral and intellectual faculties of man are evolved out of the fundamental modes of vital activity, and are differentiations (if the term may be thus applied) of the primal energies. Such, therefore, should be the guiding principle of a classification of the psychal phenomena of man.

613. Mental phenomena may be arranged according to this principle, in three principal groups of instinctive processes with their correlative teleiotic ideas: 1. Those of "vegetative" life, mainly developing the phenomena of internal or egoistic existence, as teleorganic changes; 2. Those of generation or reproduction, mainly developing the phenomena of social life; 3. Those of the sentiments and intellect, developing the phenomena of the religious, moral, and intellectual life. Each of these groups of processes has its corresponding organisation and laws of activity of the organs.

614. But then there is another point of view from which these phenomena must be examined. Energies are of two kinds, as they are relative or absolute. There is the fundamental energy, which maintains the normal condition of the organism, or that special order of phenomena in the individual which aims at good absolutely; and there is the energy which, aiming at good relatively, provides against disorder, so that the obstructions to the normal order tending to good may be obviated. Now,

this is only in fact a derivative of the other, but it demands notice, for it deals with a wholly different class of phenomena. The first mentioned correlates the permanent and unchanging in the archetypal idea; the second correlates the ever-changing and variable, and is the idea of life, and of conscious mind proper (221).

615. Then, again, it is to be remembered that this idea of the ever-changing includes that of progressive evolution from the general to the special, and from the imperfect to the perfect, under the guidance of one fundamental idea. Thus, the idea of the use of the physical forces to ends, is seen to be the most general idea in the vital instincts of the simplest cell, and the most universally operative idea in the arts of man, as developed in modern civilisation. In virtue of that fundamental energy it is that man applies the physical forces to the conquest of nature. It is by these he levels hill and pierces mountains; carries himself swiftly over the earth and ocean; communicates with his fellow-men almost with the rapidity of thought; raises immense structures; and exercises a thousand useful arts in subservience to his personal comfort and social progress; and all with a comparatively small amount of painful toil, and with ever-increasing progress towards perfection.

616. Nor is this law variable in its application to all the other arts of man; for since the fundamental energies are none other than fundamental teleiotic ideas operating as causes, it follows that the law of evolution and specialisation applies equally to them as to their causal ideas. Hence man applies the forces of nature to work out the Beautiful as well as as the Beneficial, and to attain the True as well as the Useful.

SECT. II.—*The Primordial Instincts.*

617. The most general vital energies are those by which the continued existence of the organism in time and space is maintained. They are the instincts of life common to all organisms, whether plants or animals (373). I shall designate them the PRIMORDIAL INSTINCTS; not only because they are the most universal and fundamental, but also because they are the instincts out of which all the others must be evolved. They may be divided into two orders—namely, the absolute or universal, and the contingent or derivative, according as they tend to order or the prevention of disorder, to the attainment of good or the anticipation of evil.

618. *The Absolute Primordial Instincts.*—The objects aimed at by the absolute primordial instincts in teleorganic changes may be stated approximately as follows:—

1. *Dynamization*,* or the acquisition and application of force to the continued existence in time and space of the individual and of the species. This includes the development and application of the mechanico-chemical forces, especially light, heat, electricity, and chemical affinity, to vital motion, and teleorganic changes.

2. *Alimentation*, or the continual supply of new matter appropriate to the organism, whether solid, fluid, or gaseous.

3. *Assimilation*, or transformations in the chemical relations of the alimentary matter supplied, and the assimilation, when so transformed, with the living tissues.

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* I have ventured to coin a word, so as to denote this fundamental mode of vital energy; hitherto the law has not been formularised, and no term, therefore, has been invented to designate it.

4. *Morphic Nutrition and Development*, or the putting together of the material elements supplied and assimilated, so that the form of the organism shall be evolved, and the various machines and organs developed in accordance with the archetypal idea. This is the *nisus* formations of Blumenbach—the *archæus*, *anima*, and "vital principle" of various philosophical physiologists.

5. *Succession* or *Reproduction*—that is to say, the continual reproduction of living tissues, as cells, or the like, so as to secure the material permanence of the organism.

619. *Genetic Reproduction.*—The preceding primordial instincts have reference to the life of the individual only; but the individual exists to the end that life in general shall be maintained continuously in Time and Space. Hence, correlative with these primordial instincts of the *Ego*, there is the primordial instinct of genetic reproduction or multiplication of the individual. This is the fundamental teleiotic idea of a class of vital energies, the end of which is reproduction, and which, therefore, are termed the reproductive or genetic instincts. When the new organism is *produced*, it also is governed by the egotistic instincts.

620. *The Contingent* or *Relative Primordial Instincts.*—We have seen that with order what we call Disorder is necessarily associated; that in the succession of vital events there is the permanent and absolute, but also the ever-changing and imperfect (307). Now, the derivative idea in correlation with this aberration from order and the perfect, is the teleiotic idea of anticipating and preventing the aberrant results of the derivative ideas, so that the plan shall be carried out (218).

621. The vital energies which are thus evolved are—

1. Ever-varying *adaptation* of the structure and func-

tions of the organism generally, and of its organs, in particular, to the ever-varying external conditions in which it is placed, so that the attainment of the end aimed at in its existence may be secured. 2. The *protection* of the organism, by mechanical or other means, against the external agencies with which it is necessarily in relation, and which, if allowed to operate upon it, would obstruct the normal successions and coexistences of its vital phenomena. 3. *Curation*, or the regeneration and reproduction of structures injured or destroyed by such agencies, and the restoration of disordered vital phenomena to their normal order; the energies active to this end being the same as those by which they are formed and maintained—namely, those of morphic nutrition and development. 4. *Depuration*, or the continuous removal from the teleorganic substratum of all those material elements which, having already subserved to the production or transference of force, are not further available to the attainment of the ends aimed at, but, on the contrary, are obstructive thereto.

622. *Relative Instincts of Reproduction.*—These instincts, for the maintenance of the species in time and space, follow the same order of development, *mutatis mutandis*, as those of the individual. The new individual is simply a continuance of the vital successions of the parent organisms, and energizes and is protected according to the same fundamental laws.

623. The law of ever-varying adaptation to special ends, by which these relative or contingent primordial instincts are distinguished, gives them the peculiar characteristic of reason—namely, adaptation of means to ends. This is the group of energies in virtue of which intelligent-like adaptations are effected in the nutrition,

appropriation of new matter, development of tissues, formation of means and mode of defence, depuration and curation of the organisms when these are needed. It is that class of energies which is known more especially as instinctive; which are attributed to "nature;" and which are evolved finally into the rational instincts of man. They are due to the higher evolutions of the contingent, variable, and particular ideas of the fundamental teleiotic laws, and are evolved into the highest intellectual processes of the human mind. They are therefore properly termed Psychal Instincts (468). In so far as they are limited to the vegetative vital processes, they may be termed Vital or Biotic Instincts.

SECT. III.—*The Corporeal Instincts and Appetites.*

624. The energies which we have just considered as primordial instincts are confessedly carried on in man without any consciousness on his part. As the processes by which life proper is maintained, they are those termed Vegetative. We have already discussed the question how far the operations of these energies coincide with consciousness or feeling on the part of any organism as a whole, and have ascertained that the greater part of the phenomena to be classed are wholly beyond our observation (346).

625. It is true, however, that these energies, as manifested in some organisms (for example, the higher vertebrates), may be classed with those of man in their relations to consciousness; but as we descend the scale of organisms, the great law of continuity of phenomena meets us (598), and we cannot decide where in the scale conscious life ends and automatic life begins. The wide difference of opinion upon this point is shown by the fact,

that while some physiologists deny feeling to the most highly organised insects, others consider it the attribute of a hydra or an oyster.

Such, then, being the position we are in physiologically, as to the facts of consciousness throughout organisms, let us make such an arrangement of the teleiotic and conscious processes as is possible. We can arrange them into three groups. The first will comprise the biotic processes purely, and may be said to be manifested in plants, in protozoa, and in the lowest forms of the four great branches or types of animals—the vertebrate, articulate, molluscous, and radiate. As to these, it is not possible to affirm whether there be states of consciousness coincident with the teleorganic changes; but, whether we decide one way or the other, it is certain the consciousness is so elementary that the actions are essentially automatic. The second group may be designated transitional, and will include those of the higher radiate, molluscous, and articulate branches, which have more or less consciousness, either at certain periods, or at certain stages of development; and in which the instincts proper are more complicated, and the organism more differentiated. The third group will include the conscious vertebrates, at the head of which stands man. In these the conscious phenomena are variously complicated, as the differentiation and integration of the tissues of the organism are more evolved; but there are processes which are either only performed with an imperfect consciousness, as in the second group, or unconsciously, as in the first.

626. *Instincts of Animal Life.*—To the end that the primordial instincts shall be effectively performed, various machines or instruments are necessary, and are constructed accordingly. These results of the teleiotic ideas of development serve to place organisms in adapted

relation to the external world, and to all conditions thence arising which may or do influence the well-being of the individual or the species in Time and Space. The employment of these instruments to their purposes first appears in relation with consciousness in the transitional group, being performed partly consciously, partly unconsciously. These Energies are known as the instincts of animal life—instincts of external relation, or briefly, animal instincts. Nevertheless, generically, and in so far as organs of external relation are developed in plants, they are manifested in vegetable organisms, and are therefore presumed to be performed without consciousness. But they are here considered as manifestations of teleiotic ideas in animal organs. They are necessarily evolutions of the teleiotic ideas contained in the primordial instincts, and manifested in differentiation of teleiotic structures.

627. The group of animal instincts may be subdivided into two minor groups, which, however, run into each other at many points. These are—

1. *The Organical;* in which the ends aimed at in the absolute primordial instincts (617) are sought to be attained by the use of organs or structures adapted thereto. These are the organs of prehension, respiration, digestion, circulation, elimination, and generation. They correlate mental states or desires to these ends, known as *corporeal appetites*, or APPETITES simply.

2. *The Instrumental.*—In these the ends aimed at by the primordial instincts of both kinds, but more especially by the contingent class, are sought to be attained by the use of instruments adapted to the alimentation, defence, and general well-being of the organism, rather than of machines or organs. These are the instincts of external relation. They are manifested equally in plants as in animals; but as the limited view usually taken of the

causes of life and thought has led inquirers to separate the two classes of organisms wholly from each other, they have been overlooked in plants, and have been attributed to consciousness or feeling, and therefore to animals only. Hence these instincts of external relation are taken to indicate animal life as distinguished from plant-life, and are termed ANIMAL INSTINCTS.

628. *Special Instincts of External Relation.*—Now, the last-mentioned instincts admit of considerable subdivision, according to the ends aimed at. They may be classed teleologically, as follows:—1. *Egotistic Instincts.*—These are directed to the maintenance of the individual in time and space. They are essentially the selfish, or self-seeking instincts, and have already had consideration. (480, *sqq.*) 2. *The Social Instincts.*—These are directed to the well-being of the individual, but with the higher object of the maintenance of the species, or the continuance of Life in general, in time and space. They may be subdivided into two principal groups—(1.) The family or domestic instincts; (2.) The communistic or social instincts proper.

629. The *domestic* or *family instincts* are the social instincts which unite parents and offspring in mutual support and relation. They contain three classes: 1. The *sexual instincts*, or the instincts of the sexes in affinitive relation to each other with a view to reproduction. They differ in their manifestation accordingly as they are displayed by the male or the female; and hence there are masculine and feminine sexual instincts. 2. The *parental instincts*, or the instincts by which the alimentation, protection, and general well-being of the reproduced organism are attained. They also differ as they are displayed in the two sexes, and are therefore paternal and maternal. The maternal instinct is the most universal, for in not a

few species the male parent has no part in the parental instincts. 3. The *filial*, or the instincts of offspring to the parents. These are manifested in proportion as the young organism is unable to carry out the primordial instincts.

630. The *communistic instincts*, or social instincts proper.—These are limited to orders or classes of organisms. They are the instincts whereby a number of individuals mutually co-operate for the maintenance of the species in time and space. They subdivide into the Egotistic and the Genetic. In the former, the alimentation, protection, and defence of the individual, and other objects aimed at in egotistic instincts, are sought to be attained by the community, or by a combination, to those ends, of individuals usually of the same race or species. In the Genetic group are two classes : 1. Instincts for the reproduction of the species as sexual instincts simply, of a communistic character, when no care is taken of the offspring ; and, 2. Instincts for the alimentation and defence in common of both the offspring and the parents, but especially the maternal parent. These latter are evolved in the higher organisms to a great extent, and develop republics, communities, and the like. Civilised man amongst vertebrates, and the hymenoptera amongst invertebrates, are the most striking examples of these communities.

631. This entire group of corporeal appetites and animal instincts is characterised by the quality of necessity. They are imperative on the individual; in lower organisms they are performed blindly—*i.e.*, without any knowledge of the ends arrived at in the energies. In man and the higher vertebrates, in whom there is a development of the cognitive faculties, they may be made to act as a check upon each other, and thus states of the consciousness, termed *motives*, will coincide with a knowing restraint

exercised over them. But even with the highest and strongest of human motives, and with at least some knowledge of their true character, it is often found difficult to curb them effectually. The entire group constitutes "the Flesh" of St Paul.* Those classed under the head of organic instincts, or corporeal appetites, are the most necessary to the well-being and maintenance of the organism, and are the farthest removed from the will and the consciousness.

SECT. IV.—*The Sentiments and Faculties of Man.*

632. We have already examined the principles of classification which should be applied to the higher sentiments and faculties of the human mind,† when giving a general summary of the feelings and faculties of experience. It is sufficiently obvious that we are not yet in a position to establish a sufficient classification of them, inasmuch as we do not yet know from observation the order of their development, and their relation to each other (445). We have first to establish the general correlations of structure and function, as manifested in the vital and primordial instincts, before we can pass onwards to the order of evolution and differentiation of the feelings and faculties of man. This, therefore, will be all that I shall attempt at present.

633. In the meanwhile, it will be useful to remember that, when the fundamental intuitions have been determined by observation and analysis, we shall be in a position to determine the fundamental elements of each primary sentiment and faculty; and from thence we can take a point of departure for classifying the secon-

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* *Epistle to the Romans*, chap. vii. vers. 14–25, &c.

† Part iv. chap. vi. § 1.

dary and more complex forms which arise from the *combination* of the primary. As to the fundamental intuitions, I have already indicated the most important; and since any arrangement founded upon those doctrines would necessarily coincide with the psychological classification of Gall and Spurzheim, I am inclined to adopt that classification as the best arrangement that could be adopted until our physiological analysis of mental pheonmena has had a more scientific development. Under any circumstances, the psychologist must always experience the same difficulties in the way of a satisfactory classification as the zoologist has experienced. The phenomena are so variable and complex, and at the same time so intimately related, that broad clear lines of demarcation can never be drawn.

CHAPTER V.

THE FUNDAMENTAL CORRELATIONS OF THE INSTINCTS AND APPETITES WITH VITAL MOTION.

634. The highest development of mind is shown in the knowing application of force to the attainment of ends. This is correlative with the highest development in organisation—namely, the nervous system of man. Now, we have already established the general doctrine of the teleological unity of all vital processes whatever, whether they be of plants or animals, and whether they be processes of growth, nutrition, and development, or mental processes proper.

635. But as we are aiming to establish the laws both of development and function of the nervous system, and especially of the brain, as the organ of mental activity, it will be necessary to examine the correlations of those primordial instincts out of which the mental faculties are finally evolved, with the fundamental laws of vital motion, and so establish a series of teleiotic homologies which will enable us the better to understand the laws of development of the nervous system, and the correlations of mental changes with the teleorganic or vital changes going on therein, and particularly in the encephalon. The inquiry will tend to establish the important practical doctrine, that although the nervous system in the vertebrates and higher invertebrates is essentially a special co-ordinating apparatus, whereby organs

are harmonised into a whole, yet it is not the less certain that all those functions which we attribute to the nervous system are performed in multitudes of living things—animals as well as plants—without a trace of any kind of nervous system whatever.

SECT. I.—*General Laws of Transference of Vital Force.*

636. Before we can clearly comprehend the relations of the primary instincts to vital motion, it is necessary to revert once more to the fundamental laws of life and organisation, so as to secure a sound starting-point. We have seen that the primary cause of all the phenomena of creation is the transference of force to ends. Without this there can be no change in matter, and without change there can be no phenomena (202). The changes in inorganic matter are often slow in their progress, and inappreciable to the sense, because wholly molecular; but in organic matter incessant visible change is the chief, if not essential characteristic; so that motion of the whole, or of parts of an organism, is the principal indication of life (216). When motor changes in living matter cease, the condition is that of Death. Hence the motions of living things are always the first phenomena to be investigated.

637. Three modes of transference of vital forces as visible motion may be indicated: 1. The organism moves as a whole or an individual. 2. Organs and instruments, such as cilia, hearts, limbs, move as means of motion of the organism, or of its parts. 3. A motor apparatus either acts directly as the organ of motion (as in cell-organisms) or else in the form of muscle. Now, of these three, the latter is that which is the essential element of the other two. For this histological action is only in-

ferentially visible motion; in highly-developed muscular fibre it is difficult, if not impossible, to distinguish unmistakeably a true cell-structure. Nor, as cell-action ministering to transference of forces, is the process limited to motor-cells; for, since the essential element in all the vital processes is the transference of force, there must be vital processes (although not cognisable by the senses) amongst the ultimate elements of all organisms—just as there must be motion amongst the ultimate or atomic elements of matter in all changes caused by the operation of the molecular or atomic forces (119).

638. Now, the simplest known elements of organisms are granules and cells, and these seem to be in synthesis; for although granules precede cells, as in the "mulberry" stage of development of the primordial cell or ovum, still cells equally precede granules. The latter appear to be the adapted nutrient elements—the prepared *substratum* (313) upon which the unifying and vital force acts to form a cell. Cell-life has therefore been considered a type of all life; and just as societies are integrations of organisms, so the most complex tissues are integrations of primary cells. It follows, therefore, from these premises, that tissues thus constituted by the integration of cells must, according to the law of teleiotic development, contain all the powers and properties of the cells of which they are made up.

639. Now, although we have in the varying states of our own consciousness cognitions of the results of transference of vital forces by cells and granules, in so far as they constitute the active elements of the organ of consciousness (328), those cognitions are wholly imperfect, until we can compare them with our cognitions of the objective phenomena of cell-action; for knowledge is exclusively the result of comparison of phenomena.

Hence the visible phenomena of cell-life must be determined before we can use the objective phenomena, considered as states of consciousness. These visible phenomena are of two kinds—*first*, Those which are the results of the transference of forces, and which are manifested in the simple form of visible *motion* of parts; and, *secondly*, Those which are the results of visible changes in the form and other qualities of bodies, and of which the typical form is *growth*. Under growth, we can however include all the processes which minister to growth; as transformation of tissue, repair, secretion, excretion, reproduction, and the so-called vegetative processes in general. In this way the visible motions may be taken to correlate the visible changes; and these latter those invisible modes of transference of force, operative in the encephalic structures, the results of which are presented to our consciousness as feelings, desires, energies, and the like.

SECT. II.—*Correlations of Growth and Visible Motion in Development and Reproduction.*

640. The correlations of growth and visible motion are seen in the first stages of reproduction and development. It is now a well-established general fact, that the congress and integration of two cells with reciprocal vital affinities (which may be termed Genetic cells), is necessary to the continuance of the species. In the higher organisms, these two kinds may be derived from different genetic tissues (ovaria and testes) in the same individual, as is seen in the hermaphrodite mollusks or monœcious plants; or from different tissues in two distinct individuals, as in diœcious plants and bisexual animals.

641. In the Protophyta and Protozoa there is no appa-

rent distinction of sexes, nor differentiation of tissue, for the production of cells. In these, therefore, it is the fundamental cell itself which is differentiated or dichotomised into two cells, from the integration or union of which the new organism arises. Under whatever circumstances, however, the genetic cells are produced, whether by simple dichotomy of a tissue-cell, as in the Algæ and Confervæ, or whether from a differentiated tissue, as the ovarium or testis of vertebrates, it appears now to be generally established that the process is quite analogous to that by which the growth and continuance of the individual is maintained—namely, the multiplication and reproduction of cells. So that the process of embryogeny is fundamentally nothing more than the production of a class of cells, in which the vital endowments of the entire parent organism, instead of a portion only, are integrated and potentially present; or, in other words, the cell is capable of undergoing the same successive series of evolutional and other changes which the parent organism has undergone, and of manifesting the same relation to external things, under the same or similar external conditions (291, 292).

642. Since the law of reproduction and integration of the genetic or sexual cell is a derivative of the general law of continuity in time and space of the individual, as manifested by the continual formation of new cells in the process of growth or repair, so all these other modes of energy, which subserve to the continuance of the life of the individual, are effectual to the maintenance of the integrated genetic cells. Hence it is, that either the embryo (the result of that integration) manifests the primary instincts of alimentation and defence in an intense form, or else they are manifested by the parent organism as parental instincts. These instincts are seen

in their most general form in the undifferentiated and cellular Protophyta and Protozoa, inasmuch as there is no difference in the fundamental processes. The two cells find in the parent organism all the nutrient elements that they need; and as they are for the most part in immediate relation to each other in space from the first, motion through space is not, under these circumstances, to be provided for, to effect their union. This is the process properly termed *conjugation;* while *fertilization* is applied to the union of the genetic cells of those organisms in which there is a differentation of tissue in the same or distinct individuals for the production of the two kind of cells, and motion of the one or the other is necessary to that union.

643. Now, this union, and the alimentation of the new organism, are provided for by a division of duty or labour between the cells, inasmuch as the one is exclusively surrounded by a greater or less deposit of suitable nutrient matter, fit for the consumption of the new organism so soon as life begins; while the other supplies no such provision, but has the duty of seeking out, moving towards, and penetrating to, the food-bearing cell, so as to integrate with it, to the end that thenceforward the two may exercise a joint influence on the entire future life of the individual and its offspring. The to-moving cell is the male or sperm-cell, and is the "fertilizer" of the nutrient cell, or the female, or germ-cell.

644. This entire process constitutes the primary manifestation of two great reproductive laws: 1. Of the parental instinct of alimentation, in virtue of which the young animal is supplied by the female with food from her own tissues, either in the form of the yolk, or as blood and milk; and, 2. Of the sexual instinct of the male, in virtue of which it seeks to effect congress with the

female, or to fertilize her ova. It is also one of the first examples of a physiological division of labour between the sexes.

645. Both classes of cells have each an apparatus fitted to secure their integration; the sperm-cell being, when necessary, supplied with motor filaments or cilia, and the germ-cell having a suitable apparatus for its reception, in accordance with the archetypal idea of the organism. Thus an opening termed the "micropyle," expressly adapted to receive the moving sperm-cell (spermatozoon), has been found in the ovum of "osseous fishes, insects, some of the Crustacea, the Acephalous mollusca, some Annelida, Holothuria, and some other Echinodermata. There also seems reason to believe that a similar aperture exists in the ovum of Batrachia and Cephalopoda. . . . This aperture appears to be designed to admit the spermatozoa into the cavity of the ovum, or into contact with the yolk-substance or germ, in those instances especially in which the egg-coverings are thick and tough, and fecundation is late of occurring."* In plants the apparatus is differently constructed, although it serves the same end. The *archegonium* of the Mosses is the germ-bearing organ. In the Anthoceros, one of the Hepaticæ, the teleiotic development of it for genetic integration is clearly shown. A single row of cells, commencing at the upper surface of the young shoot, and directed towards its interior, becomes distinguished from those surrounding it by the quantity of granular mucus which it contains. The lowest cell of the series becomes larger than the

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* Dr Allen Thomson, Art. "Ovum," *Cycl. of Anat. and Physiology*, vol. v. p. [133.] See Leuchart's Mem. on the Micropyle of Insects, in Müller's *Archiv*, 1855, p. 245; and Meissneis in *Zeitschrift für Wiss. Zoologie*, Sept. 1854.

rest. In its interior a "daughter" cell (germ-cell), which nearly occupies its cavity, is formed around the pre-existing central nucleus. The contiguous walls of the cells forming the remainder of the series are absorbed; hence results a canal which leads from the surface to the cavity of the basal cell, and which corresponds, apparently, to the micropyle of animal ova.*

646. The male sexual cells are termed antherozoids in plants, and spermatozoa in animals. They are both characterised by the property of adapted motions in vital affinity with the germ-cell (298). Their movements present singularly interesting phenomena. When the antherozoid of certain Fuci comes into contact with a germ-cell, it moves upon its surface, and even communicates a rotatory motion to it by the vibration of its own moving cilia. The phenomena are described by the observer as being singularly curious.† The earliest developed form of antherozoid is probably to be found in the Spirogyra, a fresh-water alga, in which, according to Itzigsohn, there are certain filaments, the endochrome of which breaks up into minute spherical aggregations, to be finally evolved into special filaments or spirozoids, having an active spontaneous movement. These aggregate into spherical masses, termed Spermatospheres.‡ These spherical masses of sperm-cells are found also in Cladophora, Closterium, and Œdogonium.

647. The movements of spermatozoa are in all respects like those of individual organisms, and are due either to the cylindrical body which some possess, such as those of the scaly Amphibia, or to cilia, or to an oar-like tail. If

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* Art. "Vegetable Ovum," by J. B. Sanderson, *Ency. of Anat. and Physiology*, vol. v. pp. 233 and 236.

† M. Thuret, *Comptes Rendus*, tom. xxxvi. p. 747 (April, 1853).

‡ *Ann. des Sciences Nat.*, *3me Ser. Botan.* tom. xvii. p. 150.

the movement of a spermatozoon be rapid, it assumes, for the most part, an accurate rhythm, like a pendulum (222). The filiform tail vibrates, and the small corpuscle or head follows the impulse. Frequently a peculiar trembling, dancing, or jumping, is exhibited by the latter, when the rest of the spermatozoon remains fixed and unmoved. A serpentine creeping in all directions is produced during a slow motion, and is caused by an undulatory contraction of the caudal appendix. They often move in one straight direction, without turning aside, and altogether in such a way and with such regularity as to resemble the locomotive movements of many of the lower animals.*

648. There seems to be no reason to doubt that the motions of these sperm-cells are adaptively subservient to their proper function—namely, vital union with the germ-cell. In fact, Leuchart observed the spermatozoa to penetrate to, and through, the micropyle of certain dipterous insects,† and Dr Ransom observed the same phenomenon in the ovum of the stickleback.‡ Yet the cells are by no means necessarily locomotive. It is probable, too, that several cells combine together in effecting the vivifying process, and that there is even united action or combined movements amongst them, and that many unite together to this end.§ This may be taken as the teleiotic homologue of what occurs in polyandrous plants: in communistic animals, as the ants and bees, amongst which many males fertilize one female; and even amongst polyandrous races of men.‖

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* Messrs Wagner and Leuchart, Art. "Semen," *Cyclop. of Anat. and Physiol.*, vol. iv. p. 503.

† *Op. cit.*, vol. v. p. [112.] ‡ *Ibid.* p. [100.]

§ Leuchart, *Op. cit.*, vol. iv. p. 504, and vol. v. p. [111].

‖ Dr Latham's *Ethnology*.

649. It is worthy of remark, that, even in this respect, growth—that is, the addition of cell to cell—correlates visible motion. Thus the pollen-grains or sperm-cells contained in the anthers of phanerogamous plants are transmitted to the ovum or germ-cell by the pollen-tubes, which grow downwards between the cells of the style until they reach its base and come into contact with the ovarium. This is sometimes placed at a distance of several inches. Arrived at the ovarium, the pollen-tube continues to lengthen until its extremity presses upon the embryo-sac, where it then delivers its contained pollen-grain. In the *Valisneria Spiralis*, this union of the sperm-cell and germ-cell by growth of organs is still more strikingly exhibited. This plant inhabits water; but the union of the two cells must take place in air. To secure this end, the female flowers are borne on long spiral foot-stalks, so developed as to secure the floating of the flowers on the surface of the water, however variable its depth; while the male or pollen-bearing flowers, being yet imperfectly developed, are detached in the water, rise to the surface, are there perfected, and finally open amidst the female flowers, so as to fertilize the ova. The whole process is the teleiotic homologue of the deposit of ova by female fishes, and their fertilization by the male; but it is completed by growth (*i.e.* multiplication of integrated cells) and not by a motor apparatus. But as if to show the variety of means by which this fundamental teleiotic idea can be effective, the physical forces of nature are rendered available to its manifestation; and the fertilizing germs of plants are transmitted by the winds, or committed to the care of busy insects.*

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* The reader is referred to Dr Carpenter's *Principles of General Physiology*, 4th edit., for an excellent account of the various modes of conjugation and fertilization in plants and animals.

650. These primordial or teleiotic laws of reproduction are the general or primary ends of the instinct of reproduction in even its highest manifestation as physical love. We have already seen how the desire for the union of the sexes is evolved in man into the highest manifestations of the æsthetic, intellectual and moral faculties (519, 520). Such feelings have at first no reference to the mere desire for sexual congress, the teleiotic idea of which is the integration of the sperm-cell and germ-cell. On the contrary, the dawning feelings of love are often of the purest, and lead only to those personal affinitive impressions which tend to excite the desire, such as kisses, caresses, endearments, and the like.

651. Nor, when the desire is awakened, and become at last irresistible, is the act of personal union completed with any reference to the union of the sperm-cell and germ-cell; yet the apparatus constructed for this end is so effectual, that man often tries in vain to prevent fertilization. In lower animals, the teleiotic operation of the desire is still more strikingly manifested. Nothing, in fact, in the phenomena of life and organisation, shows more strikingly how varied the modes, and yet how certain the result, than the conditions under which the union of the sexes is secured, and the species continued. Whatever their organisation, the tendency to union is alike uniform and irresistible: "*Amor omnibus idem.*"

SECT. III.—*Correlations of Growth and Visible Motion in the Processes of Aëration and Alimentation.*

652. Passing from these fundamental phenomena of generation and development in relation to visible motion as correlative with growth, let us examine these correlations of growth and visible motion as shown in the

methods by which plants and animals acquire air, water, food, and nutrient material generally.

653. Growth and instrumental action are equally available to this purpose. The roots of plants increase in length towards their nutriment, whether it be water or other materials; their stems lengthen to the light and into the air, to bring the aërating organs—the leaves—into contact therewith. On the other hand, while the majority of animals move upon the earth, or through air and water, by means of locomotive apparatus expressly adapted to the purpose, and thus place themselves in contact with their food; there are not wanting others which patiently await its coming to them, or create currents in the air or the water by means of a special apparatus—a ciliated epithelium—so as to direct nutrient materials to their mouths, or other organs of alimentive prehension with which they are furnished. This latter is the method followed by the class of fixed or plant-like animals, whether hydrozoa or polyzoa, and by the fixed molluscs.

654. The movements of embryo-cells in lower organisms are, however, most illustrative of this correlation. The union of the sperm-cell and germ-cell being completed, and the new individual formed thereby as a primordial cell, it also acquires the power of locomotion, although in the stage of a simple cell. This kind of primordial motion is seen in the movements through space of the zoospores of Algæ, and the "zoids" of the Zoophytes. They move by means of particular paddle-like structures, termed *cilia*. In this respect they differ from the spermatozoa, whose long filamentous tails act like the tails of fishes. There are cell-plants, however, which move by a movement similar to that of the latter. Thus the Oscillatoriæ (Protophyta, or primary forms of plant-

life) are nothing more than long filamentous cells, which seem to be in motion continually; they have a movement of alternate flexion and extension, writhing, when injured, like worms.

655. The zoids and zoospores may be looked upon as self-maintaining, self-moving embryos, or ova, in various stages of development. The end attained by their movement through space is analogous to that dispersion of the seeds or fertilized ova of plants which is so ingeniously provided for by the growth of special apparatus adapted to the motor forces of nature. Of this kind is the elegant parachute of the seed of the common dandelion. The teleiotic idea is in all cases the dispersion and development of the young organisms, under circumstances favourable to their development. But this teleiotic idea is manifested in the organisation and habits of zoospores and zoids in reference to that fundamental teleiotic idea of the law of continuance of species which aims at the alimentation of progeny. While in the higher organisms, as we ascend the scale, the young organism is more and more dependent upon the parent for food and protection, these self-moving embryos are also self-feeding, and often self-protecting. And this is the foundation of a striking difference in the respective reproductive processes. In higher organisms, the primordial cell is wholly passive in alimentation; while in the lowest forms, it is in this respect active and independent from the first. In the higher plants, a store of nutrient material is accumulated around it, constituting the greater portion of the seed, tubers, bulb, &c. In oviparous vertebrates, the yolk of the egg is the nutrient material stored up for the use of the primordial germ during a fixed period of growth (incubation). In mammals, for a like fixed period—that of utero-gestation—the

female parent supplies from her own blood all that is necessary for the healthy alimentation of the embryo; and also continues the supply, in the form of milk, for a certain period after the young animal is separated from her. In the social hymenoptera, by a social division of labour, a neuter animal constructs a protecting case for the ovum, corresponding to the shell of birds' eggs; and when it deposits the ovum therein, adds also a suitable supply of nutrient material for its use during the period of what may be termed incubation, or the larva-state. In vertebrates, the modes of alimentation and protection of the embryo and the young animal vary greatly in complexity, up to the domestic life and parental relations of man.

656. Now, throughout this entire series of homologous processes from plants to man, it is the same idea which is in operation—the modes of energy alone vary, according to differentiation of structure and evolution of relations; so that the self-moving, self-supporting embryos of the lowest organisms, are teleiotically homologous to the highest and most perfectly developed animals, both as to their general structure and modes of existence. The most complex series of vital processes and external relations adapted to the alimentation and movement through space of the highest individuals, are but the differentiations and evolutions of the structures, and their correlative teleiotic ideas, of these minute forms of vitality. Everything in them is in its most general form and manifestation. Hence their organs of alimentation are also subservient, not only to locomotion, but to all the vegetative processes, so that the cilia act as organs of both respiration and circulation, as well as of pursuit of food, prehension, and digestion. Their external surface is both aërating and absorbing—is lung and stomach;

while at the same time to it is attached all the proper instruments of visible motion. The cell-wall, with its dual elements (558), is thus the general expression of all the teleiotic ideas of life (286).

SECT. IV.—*Correlations of Growth and Visible Motion in the Conservative Processes and Instincts of External Relation.*

657. It is still believed by many physiologists, that the various instinctive and reflex acts which have had so much attention paid to them of late years are due to sensation. This class of movements have for their final object the protection of the organism from those transferences of force that would interfere with the object of its existence, or of the existence of the species in Time and Space.

658. We have hitherto mainly considered vital motion in reference to the internal organismic changes—*i.e.*, the fundamental vital processes of reproduction, alimentation, growth, secretion, and the like, or what are termed the vegetative processes; and we have seen how they correlate each other as to ends. It is necessary now to show, that these instincts of external relation, which so strikingly manifest the *lex nostri conservatio*, and the adaptiveness of which have led physiologists to attribute them to sensation,* are, like the other primordial instincts, correlative with growth to the same ends, and that the warding off of mechanical forces is a fundamental law of life.

659. In the first rank of injurious agencies are changes induced by the action of the molecular forces, represented by heat, cold, moisture, and the like, or by the mechanical forces of matter, as the motion of the winds and

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* See chap. ii. § 3,—Is Feeling a cause of adaptive movements?

waves, and the force of gravity in stones, rocks, &c. To protect from heat and cold, the whole series of organisms, whether plants or animals, are provided with mechanical appliances as coverings. Of this kind are hairs, feathers, scales, spines, silicious cases, shells, coriaceous tunics, carapaxes, or coats of mail, &c. The soft defences against heat and cold in the animal and vegetable kingdoms are appropriated to the same purpose by man; first, in their "raw" state as skins; and, secondly, as the materials of textile fabrics. The hairs which wrap up the seeds of the cotton-plant, and those which cover the body of the ruminant mammals, are the two great staples of the textile fabrics by which man protects his body from the vicissitudes of the weather, and without which there would be neither commerce nor manufactures. Mechanical injury is in like manner prevented by various means, the results of the process of teleiotic growth. Climbing plants, for example, are protected from the force of the wind by the throwing out of tendrils, as in the vine; or by the forming of aerial roots, as in the ivy, and similarly organised plants; or they hook on a support by bending the petioles of the leaves around it, as the *Canariensis.* The corallines, and the entire group of conchiferous animals, have defences developed out of chalk or carbonate of lime. By this means the coral can resist the force of the mightiest waves of the Atlantic or Pacific—waves that can lift a huge mass of rock to the height of many feet.

660. The same process of teleiotic *growth* applies the mechanical forces of matter to the formation of instruments of attack and defence in plants and animals, and their proper uses to the ends of their construction. These are true war-weapons, by which pain or injury to death may be inflicted on other organisms. In plants, penetrating weapons are constructed as daggers, with or with-

out a poison to be inserted with the weapon, and thorns, and traps, as in Venus' fly-trap. In animals, we see poisoned daggers (stings), spears, or thrusting weapons, as the sword of the sword-fish, horns, &c.; lacerating and crushing instruments, as claws, teeth, and jaws; clubs, or club-like weapons, as hoofs, heels, wings, tails, feet, and fists (in man); galvanic-battery weapons, in rays, electric fishes, and insects; stinking weapons, as in the bug, foumart, &c. These and other instruments are provided, through the process of growth, by the primordial instincts of organisms, for their use as war-weapons.*

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* "Every annelid has two bundles of hairs on the outer edge of its feet, and these threads, which, notwithstanding their extreme delicacy, are far stiffer than ordinary hair, appear to be placed on either side of the animal, to protect it against its enemies. A moment's consideration will suffice to confirm this view; for there is scarcely perhaps a single weapon invented by the murderous genius of man, whose counterpart and model could not be found amongst this class of animals. Here are those curved blades, whose points present a double and prolonged cutting surface, sometimes on the concave edge, as in the yataghan of the Arabs; sometimes on the convex border, as in the oriental scimitar. Next, we meet with weapons of offence and defence, which remind us of the broadsword of our cuirassiers, the *sabre-poignard* of the artilleryman, and the *sabre-baïonnette* of the Vincennes chasseur. Then, again, we have harpoons, fish-hooks, and cutting-blades of every form, loosely attached to the extremity of a sharp handle. These movable pieces are intended to remain in the body of the enemy, while the handle which supported them becomes a long spike as sharp as it was before. Here we have straight or curved poignards, cutting-hooks, arrows, with the barbs curved backward in order to tear the wound, but carefully provided with a sheath, to protect the fine indentations from being blunted by friction, or broken by any unforeseen shock. Finally, if the enemy should disregard his first wounds, and the weapons which have struck him from afar, there darts from every foot a shorter but stronger spear, which is

661. In animals, these various motor instruments and apparatus, adapted as well to the acquisition and prehension of air, water, and solid food, as for the removal or repulsion of injurious external things, are brought into operation by the agency of muscles—in plants, by the agency of cells. In either case, it is contact with the muscles or cells, direct or indirect, which is the true cause of the movements; or, in other words, an appropriate transference of force. These transferences of force may occur either externally or internally. In the one case they constitute external affinitive impressions; in the other, internal. The external occur in virtue of the continuity or contiguity of the elements of the tissue put into action; the internal are more complex, and require special analysis.

brought into play by a special set of muscles, as soon as the combatants are sufficiently near to grapple in close fight. It is not without reason that nature has endowed these amazons with more finely polished weapons than any wielded by paladins of old. Destined to live by rapine, and exposed to the attacks of a thousand enemies, they need them both as means of attack and defence." (*Rambles of a Naturalist*, by A. de Quatrefages, &c. &c., translated by E. C. Otté, vol. i. pp. 45, 46). The infinite variety of apparatuses of defence or war supplied to *insects* may be in some degree comprehended by reference to Kirby and Spence's *Entomology*.

CHAPTER VI.

THE NUTRIENT FLUIDS AND THE BLOOD, AS A UNIFYING AND CO-ORDINATING APPARATUS.

SECT. I.—*Unifying and Co-ordinating Action of the Nutrient* Contenta *of Cells and Vessels.*

662. IT is an admitted doctrine with the majority of physiologists, that the nervous system is the only apparatus by which the functions of organs are co-ordinated, and the vital processes unified. But it is obvious, from the briefest consideration of vital phenomena in general, that there are other means by which unity of action is secured and maintained; as, for example, in plants and in animal organisms devoid of a nervous system. The movements of the sperm-cells, zoids, and zoospores, of the Protozoa and zoophytic Hydrozoa, are all organismic movements of unity, yet there is apparently no nervous system by which their movements can be directed.

663. Now, it is probable that, in the movements of plants and lower animal forms, the unifying cause is in the direct combination of cell with cell; but unity of motion is not all the phenomena of combination to ends that they display; for there is unity also as to the various vegetative processes of secretion, excretion, growth, nutrition, defence, and the like; and of all the energies I have designated Primordial Instincts. A seeking after food, air, water, is manifested as actively in these aner-

vate organisms as in the nervate. What, then, is it that combines the movements of the tissues, or excites the transference of force to the attainment of these ends? The cause is to be found, I think, in the affinitive impressions on the vital tissues derived from the nutrient or circulating fluid, and which will vary according as it varies in composition.

664. We must revert to the physiology of the simple cell to comprehend this point clearly. In the ordinary processes of growth, there is an evolution of the *contents* of the cell. Now, these are the nutrient materials upon which the vital forces of the substratum, *i.e.* cell-wall, act. Numerous observations have been made, both upon the cells of simple tissues and those of the highly organised blood of vertebrates — the blood-corpuscles; and various ingenious hypotheses have been formed as to the laws of action of these forces, which it is not necessary to discuss at present. It may be stated, however, that there is such a teleiotic relation or vital affinity between the cell-wall and its contents, that they mutually act upon each other. This is seen in the hydrozoa, in which the cœnosarc is in manifest vital relation to the contained nutrient fluid.

665. A more striking illustration of this influence of living tissue upon the *contenta* of a cell, and *vice versa*, is seen in that coalescence of two cells, so as to constitute a dualistic unit, by which the process of reproduction is carried on in certain Protophyta and Protozoa; and, indeed, in all the phenomena of fertilization of the ovum in the higher organisms (641). First, there is a commingling of the contents of the cells, and therewith a disappearance or transformation of the cell-walls; next, around the contents thus commingled and modified, a new containing structure is developed—the outer surface of which

has the properties of an ectoderm, giving rise to organs and processes of external relation, while the internal is in vital relation to the contents. In the latter respect, the blood-corpuscles manifest the same law of integration and differentiation into higher and more complex tissues as these genetic cells, inasmuch as they are the sources from whence the capillary blood-vessels are first formed.

666. That the motor forces of circulating vital fluids arise, and are applied adaptively, independently of a nervous system, or of anything like it, is amply shown by the circulation of plants. The circulation in the Chara (an aquatic plant) was made a subject of observation by Corti in 1774, by Fontana in 1776, by Treviranus in 1807, and by Amici in 1818. In 1837, M. Dutrochet repeated and confirmed to a great extent the observations and experiments of these naturalists, and in addition (in conjunction with M. Becquerel) instituted experimental researches as to the influence of heat, galvanism, and electricity upon the motion of the fluid in the vessels of the plant. This fluid contains globules or corpuscles, and circulates spirally up one side of the vessel and down the other, with a continuous regularity. The vessel is lined with serial arrangements of green corpuscles, taking a spiral direction (252), and it is to these that the movements of the circulating fluid and its contained globules are due; for, wherever they are defective, there the progress of the circulation is retarded or arrested. These green globules or cells have themselves the power of locomotion; since, if they be detached from the tube which they line, they roll about in a spiral form; or if they are accidentally turned upside down, they rectify their position. M. Dutrochet believes they are nascent cells, and have their motor power in virtue of the general law of life by which nascent cells are endowed with motor properties. And he

quotes M. Payen* as having determined, by chemical research, the important fact, that every nascent organ or structure in plants contains more nitrogenized matter, than when fully developed. This is also the law with the lowly forms of plant-life, as the fungi, and the Chara itself is not an exception.† Now, these vital movements, it is proved, depend upon heat and light, and not upon a nervous system, nor anything like it.

667. This correlation of action between the vital substratum and the nutrient material in affinitive relation with it, is itself, in fact, due to a differentiation of the general law of relativity. It is a teleiotic manifestation of that teleiotic idea of unity, in virtue of which organisms not only exist in time and space, but exist in a definite form, and in definite relations to external things. And this is abundantly shown by the fact, that in plants these fundamental laws of form and unity, and adaptation to external agencies, are manifested as plainly and conclusively as in animals. Not only is the root in relation to the trunk and leaves, but the ova or seeds, as in animals, have those qualities of archetypal evolution so impressed upon them, that the same mode of development of the stem, and leaves, and flowers, shall take place, both as to size, form, colour, and other characters, under the same conditions, from generation to generation. This is particularly shown in cultivated flowers. The unity of organisation in time is maintained, or the species or variety kept up, independently of any nerve or ganglion. Now, the agents in this process can be none other than the tissues in relation to their nutrient elements.

668. That the state of the nutrient or circulating fluid

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* *Comptes Rendus* (1838), p. 131.

† "Obser. sur la Circulation, &c., chez la Chara Fragilis," *Mem. de l'Acad. des Sciences*, tom. xviii. p. 439.

has a direct influence upon the vital processes of plants, is manifest from various considerations. It is this which determines the health and vigour of the plant. Remove from the soil those mineral elements which are necessary for the proper formation of its tissues, and the plant either ceases to live altogether, or is imperfectly developed. Upon this general law is founded, indeed, all the doctrine of soils and manures in horticulture and agriculture.*

669. The action of poisons upon plants may be noted, as demonstrating how close is the analogy between plants and animals in respect to the relations of the circulating fluid to the vital actions of its containing tissues. It is generally thought that the spasmodic actions induced by brucia, strychnia, opium, &c., are due to the direct influence of the poison upon the nerve-tissue. This may be so, yet perhaps the muscular system shares more in these phenomena than is generally recognised; but it appears that the poison certainly produces congestion of the internal vessels of the spinal medulla, so that they become varicose, or even burst and allow blood to escape. Such also is probably the result of poisons acting on the sensorial nerve-centres, as chloroform, nitrous oxide, alcohol, belladonna. Now, plants suffer equally with animals from the operation of these poisonous agents on their tissues, when received into their circulation. Many years ago, M. Macaire showed experimentally that infusions or solutions of *nux vomica*, belladonna, laurel water, and prussic acid, proved rapidly fatal to bean-plants. M. Marcet also

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* See Liebig's *Letters on Agriculture* (translated by Dr Blyth), for a most able exposition of this law of development of crops of different cereals in succession, according as each robs the soil of its proper nutrient elements. The science of the culture of named flowers of the florists is dependent upon the same general laws.

found that prussic acid and opium destroyed the sensibility of the leaflets of the sensitive-plant (*Mimosa pudica*) and of the stamina of the *Berberis vulgaris*. He also found that he could modify the phenomena of what is termed the sleep of plants—that is, the closure of the flowers over the sexual organs at night—and the like, by these narcotics. Drs Turner and Christison proved experimentally, that the gases which affect injuriously the nervous system of man are also injurious to plants.

SECT. II.—*Co-ordinating Action of the Blood in relation with the Capillaries and Primary Elements of Nerve-tissues.*

670. We have as yet looked at the nutrient fluid simply as a co-ordinating agent. Its function in this respect is still more distinctly shown when it circulates as blood in and through all the tissues of animals. Blood, however, is itself a highly differentiated thing, and appears, therefore, in a much simpler form in the lowest organisms than in the higher. Thus, as we ascend from plants to plant-like animals, or zoophytes, we find that the common nutrient cavity of the polype represents the circulating apparatus, and that consequently the fluid it contains is the teleiotic homologue of blood. Advancing higher, the perigastric cavity of the annelides is manifestly a differentiation of the common nutrient sac of the polypes and molluscoid polyzoa. Here, however, we have a more highly elaborated nutrient fluid, inasmuch as the annelides, for the most part, are feeders on the blood of other animals, so that even red blood may be developed. The mode of distribution of the fluid is typical, however, of that which occurs in the most highly differentiated form of the circulatory apparatus in the most complex organisms.

671. The circulatory system in higher animals ad-

vances *pari passu* in its differentiation with the evolution of the blood-corpuscle, so that it attains its highest development in the red-blooded animals. The nutrient material in the simpler molluscs is, however, brought into direct contact with the living tissue without the intervention of blood-vessels; this is seen in the relations between the fluid of the cœnœcium and the polyzoon, and between the chylaqueous fluid and the tissues it bathes. As these become more complex, the blood is more differentiated and integrated; while a complex nervous system is also evolved, so as to co-ordinate the blood and tissues.

672. The fundamental idea of the blood-corpuscle itself is, however, that it is a contractile cell containing a nutrient material, and that it is in adapted relation as such to the ultimate elements of the organism among which it moves. Hence, the corpuscle is the general manifestation of that teleiotic idea which is evolved in the entire blood-distributing apparatus, and in the functions of the capillary-walls; so that while the persistent contractility of the vaso-motor fibre of the latter represents the contractile function of the cell-wall, the vital affinities and powers of the capillaries correlate the fundamental powers of the blood-corpuscle as a primary form of cell.

673. In the higher organisms, the capillaries are therefore the essential organs of nutrition and of vital action, and the primary tissue of the vascular system itself. They appear to be integrations of blood-cells or corpuscles, being constituted primarily by the fusion of these corpuscles into each other, in such a way that, while the outer wall becomes continuous, the septum-like portion, which separates one wall from another, when in close opposition, is removed. The capillaries have therefore a

contractile power over their *contenta* independently of the heart, like the vessels of the Chara, just referred to (666).

674. Now, that the blood is the co-ordinating agent in the motor functions of the capillaries, seems to be generally admitted. This it is in virtue of the general law of Relativity. But in the lower plant-like animals, the nutrient blood-like fluid seems to be the co-ordinating agent of the common motor apparatus of a society or combination of organisms, so that the vital changes it excites in one will be equally excited in all. In this way the disc-like foot of that curious polyzoon, the *Cristatella Mucedo*, which is a colony or society of molluscs with a common locomotive apparatus, may be co-ordinated in relation to each "zoonite," through or by means of the nutrient fluid which circulates through it.

675. While, however, the motor powers of the capillaries are thus shown to be derivatives of that law of vital affinity between the living tissue and its contents which is the general law of vital motion, the idea does not exclude the higher influence of a nervous system (when that is developed) upon the motion of the blood in the capillaries, and upon the changes which go on in the blood and tissues to which it is distributed. When nerves accompany the vessels, their function is only a higher evolution of this same general law, and is necessary to secure more effectually the unity of function and relation of all the multiform elements of the organism, that have to co-operate in action to the ends of its existence. Perhaps the most fundamental property of the nervous system, in this respect, is the *teleological distribution* of the blood here and there into this organ and into that, according to the needs of the organism as a whole, or as to the needs of its parts.

676. According to this doctrine, it follows that although all the functions of an organism may be duly performed without any nervous system, yet, when the nutrient fluid is more highly differentiated into that which we call blood, then all the processes which primarily depend upon it, such as secretion, excretion, growth (or multiplication of cells), and the vegetative processes generally, are harmonised or co-ordinated by the nerves, through their influence on the motor powers of the blood-distributing capillaries. And Professor C. Bernard has shown experimentally that the so-called trophical or nutrient nerves are in fact (as has long been believed) motor nerves of the sympathetic class.*

677. It is worthy remark here, that the glands are in important relation to the blood, whether they be considered as organs of secretion, excretion, or sanguification. Since they are differentiations of the simple alimentary membrane, as in the zoophytes, they manifest generally all the functions of that structure. Thus, just as the opening into the simple stomach of the zoophyte manifests a power of selection as to what is fit and useful for the animal, so the mouths of the glandular ducts have a special receptivity of impression; or, as Professor Claude Bernard expresses the fact, with reference to the pancreatic and bile-ducts, it appears as if the glands exercised a sort of gustatory sense by means of these surfaces, in virtue of which they are capable of being stimulated by certain agents to pour forth their contents.† But it is to be observed that this power of selection—this vital force of affinity of the living tissue—is not dependent upon the nerves; on the con-

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* *Leçons sur la Physiologie et la Pathologie du Système Nerveux* (1858), vol. i. p. 320, and vol. ii. p. 148, *sqq.*

† *Op. cit.*, tom. i. p. 322.

trary, when a nervous apparatus is the seat of it, it is only as a result of the specialisation of the law of selection.

678. It cannot be doubted, therefore, that while there is an intimate relation on the one hand between the blood-vessels and the blood, and on the other hand between the blood-vessels and the nerves, there is an important correlation of function between the blood and the nerve. The blood is, in truth, a body of floating cells coming into continual contact with the histological elements of the nerves and nerve-centres, in common with those of all other tissues, as it circulates through them. Now, considered from this point of view, the blood is in fact situate externally to the nerve-cells, just as the nutrient fluid is in contact with the surface of the endoderm in the polype; and as they are the tissues in which the highest specialisation of that law of adaptation which is manifested generally in the polype, it is obvious that their function in relation to the blood will be characterised by the highest adaptation to the ends of the organism. Hence the nervous system may be looked upon as an immense co-ordinating apparatus, the function of which, in relation to the blood, is to maintain the integrity and fitness of the nutrient fluid, to distribute it fitly to all the manifold differentiations of organs, and to subserve to the proper deposit from it of all those elements which are required to be deposited in differentiated structures, whether in the course of nutrition, growth, repair, or excretion.

679. On the other hand, the blood may be looked upon as an external stimulus to the co-ordinating apparatus, and to each particular differentiation of it, whether it be nerve-cell or ganglion, without which no proper tele-organic changes or co-ordination of organs and tissues would occur. In this way we can understand how the varying conditions of the blood may not only excite

special states of feeling, as hunger, thirst, and the like, but also excite reflex or automatic activity of motor apparatus, as promptly as an external stimulus would excite them. Such stimulation of the nerve-centres by the blood, when morbid, is the source of an endless variety of diseases of the nervous system, from mere neuralgia, or simple spasm, to every kind of mental disorder.

680. And with reference to the relations of the blood to the nervous system especially, and to the tissues of organisms generally, we may from these considerations conclude that the laws of those relations are of general application to the phenomena of the Primordial Instincts (617). Thus, the depuration of the circulating fluid, and the action of the secernent structures to that end, are as much under these fundamental teleiotic laws, as the supply of aliment generally, or of certain special materials required for special purposes, as lime for bones, protein compounds for muscles, phosphorous elements for the nervous system. There is no tissue or organ without its special relations to the circulating fluid, whether it be a simple secreting cell of a gland, or whether it be that highly complex organ upon which Thought and Will depend. And it conclusively follows, that the knowledge of these relations is of the highest importance, not only to medical science in the treatment of disease, whether of the tissues generally or of the brain in particular, but to one of the highest departments of political economy—the production and supply of proper food to the people, so that they shall attain to the greatest vigour of both body and mind.

CHAPTER VII.

CORRELATIONS OF THE SYMPATHIES AND ANTIPATHIES WITH THE PRIMORDIAL INSTINCTS.

SECT. I.—*Correlations of the Visceral or Internal Sympathies with Primordial Instincts.*

681. Looking at the simplest organic form in which there is a specialisation of function, we find that portions of an apparently homogeneous tissue—as the endoderm of the hydra—take on different functions (557). These are in special relation to the blood, to each other, and to the whole organism. Of the last mentioned, the evolution of the sperm or germ-bearing tissue is an example; of the former, the intus-susception of food and air, and the elimination of bile, urea, and the like, from the nutrient fluid or organismic tissues.

682. Now, this specialisation of function may be correlative even in these homogeneous-looking organisms with differentiation of structure, although the structure be not cognisable with our present means of research but in the higher organisms, that differentiation is very manifest in the formation of special organs of intus-susception, digestion, depuration, and the like. These are the organs, therefore, which are subservient to the "organic" instincts, or *appetites* proper (627; 1). Now, the nutrient fluid acts upon the telciotic homologues of these organs in the hydrozoa, and the zoids and zoo-

spores, as a unifying instrument; we should therefore expect to find the same end manifested in the influence of the blood upon the functions of these viscera, so that they shall be in co-ordinated relation to each other. Such, indeed, has long been known as a general fact of experience in both physiology and medicine, and has been formularised in the doctrine of vicarious action.* These phenomena are due to complex causes. It is obvious that the internal relations of these organs are not dependent exclusively upon the relations of mere contiguity, as might be inferred from the homogeneous continuity of the homologous visceral tissues of the hydra or amæba; but that relations as important are afforded by the nutrient materials, and by the ever-flowing, ever-changing, circulating fluid, both which are in as definite or affinitive relation to the organism as external things, or as one contiguous portion of tissue to another. In animals endowed with a nervous system, these teleiotic relations of the blood to the organismic tissues, as the conveyer of nutrient materials, are specialised in a correlatively differentiated tissue. Hence, those of its constituents which are necessary to the maintenance of the individual, or of the species, will be sought after just as automatically by the more highly-developed organisms as by plants and the animal organisms in which no nervous system has been discovered. This will occur although there be no consciousness whatever; while, if there be the endowment of consciousness, the nutrient materials, when wanting in the blood (as air, food, or water), will become an object of desire. That desire will be intense in proportion as the need for the material is urgent, and in proportion to the need and the desire will be the vigour of the efforts for the fulfilment of the desire. Hence, hunger, thirst, and the air-appetite, are amongst the most imperative and uncontrollable of the desires and instincts.

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* Twenty years ago I applied this doctrine to pathology, and showed that in certain forms of hysteria there occurred what Dr Mason Good designated *Paruria Erratica*, or erratic discharge of urine or urinous fluids from other surfaces than the renal; and that this took place in consequence of important changes in the nervous system, and especially of that portion in relation with the functional activity of the kidneys. (See my *Treatise on the Nervous Diseases of Women* (1840), part iii. chap. ii. § 2 (*a*): and my paper in *Edin. Med. and Surg. Journal*, on Hysterical Ischuria (Jan. 1838). I also applied the same doctrine to explain vicarious menstruation.

683. Now, this action of the blood on the nerve-centres, as the co-ordinating apparatus of the organs subservient to the appetites, is wholly internal. But the organs themselves are subject to the influence of affinitive impressions, and through these are in such relation with the nerve-centres, that they are combined together, as well as with all other structures of the organism, into a harmoniously acting whole. Thus, when the organ of digestion is empty, its affinitive impressions are such as to help to develop the feeling of Hunger, or desire for food, which the defect of nutrient materials in the blood circulating through the nerve-centres induces, and thereby intensifies it. In like manner, dryness of the throat and mouth (the organs of intus-susception of water) intensifies the feeling of Thirst, or desire for water experienced when it is defective in the blood.

684. The best and most instructive illustration of this visceral action on the nerve-centres—this development of internal excitants through distinct organs—is seen in the action of the generative glands in the development of the desires and instincts subservient to the maintenance of the species. The functional activity of these

glands is not continuous in time; or, in other words, there are periods of cessation of activity, when the maintenance of the individual is the principal object of the instincts and desires—and periods of activity, when the congress of the sexes, and the alimentation and defence of the young organism, is the great business of life. During this genetically active period, numerous faculties otherwise dormant, or only *potentially* present, are brought into active exercise. Such are the instincts to migrate, to unite with the opposite sex in common duties, or, with the community, to construct houses, and to fight. Vocal powers are then developed, and the male rings forth his challenge to his rival, or calls or soothes his mate with his voice. The female also changes, and becomes bolder and more cunning. During the spring months of March and April, under the influence of the generative glands, the whole of the instincts named Propensities by Phrenologists may be observed to be developed in highly social animals. Thus "Amativeness, Philoprogenitiveness, Inhabitiveness, Combativeness, Destructiveness, Alimentativeness, Secretiveness, Acquisitiveness, Constructiveness," are seen active in all the busy life of a rookery during the breeding season. Also the sentiments of "Cautiousness, Benevolence, Conscientiousness;" and even some of the higher faculties subservient to the constructive art, as "Form, Size, Weight, Language."

685. Now, it has been clearly shown by Jenner, J. Hunter, and others, that in birds the ovaria and testes enlarge with the advent of the breeding season, and waste when the process is completed. Hence, the changes in the nervous system upon which this evolution of the instincts depends are due to the action of the genetic glands; so that, with the cessation of vital activity in these organs, the social business of the rookery returns to its normal

condition. The amatory pairings, the joint construction of nests, the plundering of neighbours, the fights, the courts of justice on thievish couples, the punishments of convicted delinquents, all cease, and the "philoprogenitiveness" and "amativeness" are no longer manifested. The object of the genetic instinct being attained, and the young reared, the members of the community settle down into the ordinary exerciso of their communistic instincts of alimentation and defence; teaching, possibly, the younger members of the corvine community how to act as sentinels, and recognise from afar "the tube of fate."*

686. That these periodical instincts are not dependent, directly at least, upon minor external stimuli, is shown by the fact that caged birds, even when solitary, that is, without mates, begin at the proper period to perform various instinctive actions appropriate to the breeding season, such as taking up materials for nests, constructing nests, laying eggs, singing, &c.; and when the breeding season is ended, and the period for migration is come, the same manifestation takes place—the bird, if of a migratory species, seeks to escape, or becomes more restless than usual; and if by chance it does escape, impelled by its communistic instincts, it joins the members of its genus or species in their migratory flight.

687. The true primary excitement of these genetic instincts is *heat.* Hence it is, that in animals and plants exposed to all the vicissitudes of the weather, the order of succession of phenomena corresponds with that of the seasons. There are, however, a number of derivative laws of

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* Additional proof is to be had, if necessary, from the fact that the sexual instincts in all the vertebrates are only developed in adult animals; and an animal is adult, *i.e.* has attained its full or ultimate development, when the sexual organs are perfected. Further, if the glands be removed, the instincts are not manifested.

periodic change in the generative glands, which become laws of vital periodicity, such as the periodicity of ovulation in woman and the females of some of the higher mammals.[*]

688. This large and complex group of causes of mental states, in which the blood and the viscera co-operate together in developing changes in the brain, are little recognised by the majority of mankind, so far at least as regards the influence of the heart, lungs, and sanguific viscera. The influence of the generative glands is practically recognised in the management of domestic animals; and hence they are removed, when it is wished to develop certain mental or corporeal characters, or to repress others. The removal of the generative glands of human beings has been practised on male slaves from time immemorial in the East for the same reason; according to Athenæus, even female slaves were thus mutilated in ancient times. It has also been found that certain kinds of food and drink, and certain drugs, have an important influence upon the appetites and passions; and this knowledge has therefore been used to excite or repress the desires, either by using or abstaining from them. Nor has the action of the viscera been wholly neglected. Thus the liver was considered to have an important influence upon the instinctive or relative feelings and acts. Hence, a *choleric* man implies not only an irritable man, a man given to the war-instincts, but the cause of his irritability, defective elimination of bile.[†]

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[*] I have already demonstrated these laws in my *Treatise on the Nervous Diseases of Women*, part i. chap. iii.; and also in the *Lancet*. vol. i. (1842-43), pp. 124 *sqq.*, 162, and vol. i. (1843-44), p. 84.

[†] Illustrations of the operation of these visceral and blood-sympathies in insanity and disease generally are given in my courses of Medical Psychology and Practice of Medicine. The reader will find an exposition of some of them in my essay "On

SECT. II.—*Correlations of the Organic Sympathies as Appetites, with Primordial Instincts.*

689. The various viscera in and by which the primordial instincts of alimentation and assimilation are manifested, have instruments or organs of intus-susception in teleiotic relation with them; so that, when necessary, the thing to be assimilated can be acquired, taken, or seized and transmitted to the assimilating viscera. These instruments vary greatly in organisms as to their construction and use. In the Amæba, the entire body of the animal is equally an organ of aëration, prehension, intus-susception, digestion, and assimilation. In animals more developed, a simple sac is the air-receiving organ, and cilia or tentacula (which are integrated cilia) are the chief instruments for the intus-susception of food. As we ascend into the more highly evolved forms of animal life, more highly developed instruments are found in great variety, adapted to the purposes of seizing, crushing, tearing, and triturating the food; or for the rapid and continuous intus-susception of air, and its assimilation with the blood.

690. But if we proceed to examine the general law by which these various organs are put into relation with external things, we find that they act in consequence of the impingement upon them, either directly or through a recipient apparatus constructed for the purpose, of an affinitive impression, made by an appropriate thing. Thus, the Actiniæ in an aquarium may be seen to close their tentacles rapidly upon a piece of beef, or of an oyster or a crab, but to take no notice whatsoever of inorganic things, as a bit of shell. So, also, the young

some of the Latent Causes of Insanity," *Journal of Pyschol. Med.*, April, 1854.

mammal in the act of sucking receives an impression from both the milk and the teat, or nipple. In like manner, a chicken, as soon as hatched, will attack a spider when it sees it, for the purpose of eating it.

691. This process is wholly automatic—*i.e.*, is independent of consciousness or experience. Galen's experiment on a fœtal kid, which ran to milk and drank it, the moment it was taken out of the uterus of the goat, proved this long ago. The law is therefore as simple as it is general. There is in all the lower animals no instruction as to the use of these organs, and no experience as to the states of the consciousness with which they are associated. The external impressions act through an appropriate recipient apparatus upon an appropriate nerve-centre, and therein the teleorganic changes take place, which on the one hand excite the states of consciousness, and on the other the direction and concentration of the motor forces to and upon the appropriate muscles. Hence the relations of the organs to their external stimuli, and to the mind, are fundamentally the same as in the class of internal stimuli; only, in these latter, the varying composition of the blood or the states of the viscera act directly upon the appropriate centres, and excite the appropriate acts.

692. It is of importance to remember, that however complex may be the source of the affinitive impressions, and however extensively the impression, considered as a sensation or perception, may be the result of integration of the many, it is still one impression, and acts, therefore, with all the rapidity and directness of the simplest form (470, 471). Thus the smell of food cooking, or a mention of food, operates in man according to the same law as the simplest contact of an appropriate article of food with the tentacula operates on a polype. The difference is not in

the law of action in the two cases, but in the properties of the vital substratum of each.

SECT. III.—*Correlations of the Sympathies and Antipathies proper with the Primordial Instincts.*

693. We divided the relative instincts into the individual and the social; and the social, into the domestic or family instincts, and the socialistic instincts. The *social* serve to influence societies of families, or families combined, to maintain the species and defend the individual, and specially include the instincts of alimentation, reproduction, and defence of individuals, parents, offspring. Such a group comprises a great variety of relative instincts—namely, as between natural enemies, or those which prey and are preyed on for food, between the sexes, between parents and offspring, between members of the same species. It also comprises a variety of constructive instincts, or instincts subservient to the construction of weapons, snares, traps, stores, shelter, coverings, dwellings, and the like, in or by which the great fundamental objects of the primordial instincts are attained—viz., the maintenance of the individual and the species in time and space. (657, *sqq.*) The whole group mainly corresponds to the first genus of the Affective Faculties of Spurzheim—namely, the PROPENSITIES—and are associated with relative feelings, termed Sympathies and Antipathies.

694. A thorough analysis and examination of the various instincts of the group would trench too much upon the plan of this work: nor, perhaps, is it necessary; for as the same general principles apply to all, it may suffice to lay down these principles, and illustrate them by an analysis of one of the chief and most important

groups. Now, organisms are in relation to each other for two fundamental purposes—namely, attack and defence, protection and destruction, help and injury. The energies by which these ends are attained may be termed the war-instincts; and on account of the fundamental relative influence they exercise over man in the exercise of his relative duties, whether as a fellow-man, parent, or citizen, they have the most important bearing on morals.

695. In those animals which prey upon other animals, or are carnivorous, the instinct for attack arises primarily out of the primordial instinct for alimentation. It is therefore intimately connected in these classes with the feeling of hunger; and in proportion as that is developed, in the same proportion the animal, other things being equal, is furiously combative and destructive. This is a matter of everyday experience with the lower carnivora. In man it is shown with equal force, although rather as a change of temper than as a mere instinct. Thus, when the nutrient materials are defective in the blood, or it is imperfectly oxygenated, the man becomes "irritable" or quarrelsome, even when the feelings are well under control. If, however, there be coincidently a morbid state of the encephalon, or if it be imperfectly developed, as in idiots, hunger may be accompanied by a tendency to homicide or suicide, or may develop brutally ferocious propensities.

696. The war-instinct is, however, manifested as a socially protective or defensive instinct. It is thus developed as a primary instinct in gregarious animals, as oxen or horses, during the operation of the reproductive instincts, when the males defend the females and their young from the assaults of carnivorous foes. It also arises in the adult female animal during the period that the young creature is dependent upon her for protection.

There is another manifestation of it, also, in the duelling-instincts amongst the males of gregarious animals; the end of which is, that the strongest males of the society carry on the process of fertilization of the germ-cell. It is a manifestation of the teleiotic idea of maintenance of the species, not only simply, but in health, strength, and beauty. In this and the preceding cases, the development of the instinct is in intimate relation with the generative glands, and is a part of the sexual instincts; for if these be absent or quiescent, the instinct is not manifested (685).

697. The instinct for protection and defence of the person, and therefore for attack *in* defence, is not, however, more directly dependent upon the state of the alimentary or reproductive functions, than upon conditions beyond the sphere of the organism. If attacked, it must protect itself by such modes as may be most advantageous — that is, most in accordance with the ends of the organism. This may be accomplished either by flight, or by deception and stratagem, or by use of natural weapons of defence; or it may be socialistic—*i.e.*, in common with other individuals of the species—as in herds, or flocks, or swarms. In the same way, if its food or stores of food be attacked by its natural enemies, it must incur the danger of loss of food, or fight in defence of its food or its stores. These social war-instincts attain their highest development in the military science and tactics of man.

698. There is a large class of contingent relative instincts, the psychology of which has been already examined as the Egotistic Faculties, and which are often manifested as instincts of attack and defence. (480, *sqq.*) The same laws apply to the antipathies and sympathies which arise in connection with these modes

of energy, as to the fundamental forms. And this remark applies equally to all the higher sentiments of man. These relative instincts being all active instincts or instinctive *faculties*—not merely states of feeling—are not simply in relation with the desires which accompany them: they have also a relative bearing on the organisms, towards which they are the expressions of the feelings of sympathy or antipathy, of seeking or aversion; so that, as regards the moral relations of man—that is, his social sentiments—they are in fundamental relation to the Will, in or by which man executes that which he desires, and thereby becomes criminally amenable to the laws of society. So that the fundamental laws of action of these instincts require to be fully understood, both for sound legislation and the just administration of the law, as well as for the proper comprehension of all those principles of conduct, and their practical application, with which morals deals.

699. These instincts are very commonly disordered in insanity; and as that state is allowed to be one in which the man is not morally responsible for his actions, the plea of insanity is not uncommonly set up in cases of felonious assaults, murder, homicide, rape, fire-raising, theft, and other criminal contraventions of the law.

CHAPTER VIII.

CORRELATIONS OF THE COMMUNISTIC INSTINCTS WITH THE FUNDAMENTAL LAWS OF DIFFERENTIATION AND INTEGRATION IN MORPHOLOGY AND DEVELOPMENT.

700. We have already seen that vital energy tends to unity in two modes—viz., by the union of the One and the One, or Duality, and by the union of the Many into One, or Plurality. The union of the one and the one in development is the cause of *bilateral symmetry*. As this is the great characteristic of the nervous system in the Vertebrata and Articulata, I shall defer the consideration of its laws until we have to speak of the laws of development of the cerebro-spinal axis. It may be here observed, however, that the one and the one in bilateral symmetry are each really constituted of the many; hence it will be necessary, in the first instance, to examine development in relation to the fundamental idea of the union of the many into one. Now, this development has not relation alone to the union of the parts of an individual organism into a harmonious whole; on the contrary, in those organisms in which there is the greatest complexity of parts, there is also manifested the operation of the socialistic law of union of individuals to a common end. This is manifested in lower organisms mainly for the attainment of the continuance of the species; in man, it reaches its highest development in aiming at the progressive improvement of the species.

701. If we take a general survey of the nervous system and its functions, we shall find that it performs those offices in the organism which the governing power performs in a combination of human beings, such as an army, or the civil service of the State. The whole system is one in which there is a successive combination and integration of individuals in a more and more compact ratio. Thus, in an army, privates are integrated into a company; and thence by higher and higher composition, through regiments, battalions, brigades, and *corps d'armée*, into that one mighty engine of power and human strength, a complete array or army, which one man rules as the commander-in-chief, and to whose will, through a succession of subordinate wills, every officer and private is subject. This one mind puts into efficient action all those instruments of offence and defence, and those means of locomotion, alimentation, and protection from the physical forces of nature, which make up the material weaponry and locomotry of the army, down to the arms and legs of the humblest private, or of the beast of burden. Now, this is precisely the law by which distinct organisms, termed *zoonites*, are united into a composite organism; such a compound organism as an army (to compare small things with great) is one of the highly carnivorous annelids, whose every segment is a separate organism armed at all points (p. 216).

702. This is also, in another way, the law of development and structure of the nervous system: its radicles or first elements, the nerves, commencing in the elementary tissue, accompanying the blood-vessels to their minutest distribution of nutriment, and regulating the movements of the multitudinous muscular fibres, gland-ducts, and secreting cells of the muscles and viscera, are integrated into centres of union and relation at various points in the

organism; then these centres are combined into a larger system of centres, and so on in an evolving and ascending progress, until the entire co-ordinating apparatus is developed (in vertebrates, the cerebro-spinal centre or axis), through which the unity of all the multitudinous parts of the organism is effected, so that the processes of each separate system are not only co-ordinated, but the sum of each is co-ordinated with the sum of the others.

703. This co-ordination of subordinate elements is not however absolute in organisms any more than in an army. Every unit of it, and every system, has within itself its own powers of existence, just as the private soldier exists, although cut off from the main body; the co-ordination is only *absolute* as regards the perfection of the whole, while it is relative as regards the mutual co-operation of the parts to that end for which the whole is constituted. In organisms, in short, there is no such thing as absolute unity of parts, because there is no such thing as absolute perfection of organisation; but in proportion as perfection is reached towards, in the same degree absolute unity is approached; and as the former is necessarily coincident with the highest multiplicity or differentiation of organs, so is the latter. Hence we have in man the manifestations of these two conditions of the most perfect organisation—namely, the highest differentiation and the most absolute unity (304).

704. Goethe (we have seen) was amongst the earliest of modern thinkers to develop this law of socialistic unicity (277). "Every living being," he remarked, "is not a unity but a plurality. Even when it appears as an individual, it is the reunion of beings living and existing in themselves, identical in origin, but which may appear identical or similar, different or dissimilar. The more imperfect a being is, the more do its indi-

vidual parts resemble each other, and the more do these parts resemble the whole. The more perfect the being, the more dissimilar are its parts. In the former case, the parts are more or less a repetition of the whole; in the latter case, they are totally unlike the whole. The more the parts resemble each other, the less subordination is there of one to the other. Subordination of parts indicates high grade of organisation."*

705. Geoffroy St Hilaire, Carus, Marcus de Serres, have each pointed out, more or less distinctly, the individual character of the segments of the Invertebrata, and the social character of the entire animal, considered as an individual organism. Moquin-Tandon of Toulouse, and Dugès of Montpellier, have given a scientific development to these ideas. Dugès adopts the phraseology of the former, and terms that group of coordinated organs which can maintain an independent existence an *organism* or *zoonite*, while the combination of organisms or zoonites into a socialistic unity is an *animal.*† Thus each segment of a Tænia is a zoonite; the entire chain is an animal. M. Moquin-Tandon derived his first ideas from a work of Duval, his friend and teacher, printed but not published, who suspected that there is something in the constitution of animals analogous to that of plants—*i.e.*, that they are an aggregation of elementary beings. This idea he applied to the natural history of leeches with great success.‡ He is of opinion that every five segments of the medicinal leech

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* *Life and Works of Goethe*, by G. H. Lewes (1855), vol. ii. p. 151.

† *Memoire sur la Conformité Organique dans l'Échelle Animale.* 4to (Montpellier, 1832), p. 13.

‡ *Monographe de la Famille des Hirudinées*, 1st edit. 1826, 2d edit. 1846.

may be considered as a distinct organism, inasmuch as they have a complete set of organs—namely, a nervous system with its œsophageal ring, a digestive system, and organs of circulation, locomotion, and reproduction. The leech, therefore, according to his view, is a composite animal, made up of a certain number of animals, as a tree is a composite organism made up of a number of plants; so that there is no real individuality in the leech.* It has two kinds of lives—a general life, or that of association of the separate individuals; and a special life, or that inherent in each *zoonite.* Each ganglion in the chain is really the brain of each zoonite; the general harmony—the unity of the zoonites—is secured by the commissural or internuncial cords, which run between the ganglia. The anterior zoonite, or that which is endowed with the œsophageal ring, being in relation with the organs of special sense, is the most intelligent. It is the ruler of the other zoonites,—the leader of the club,—the commander-in-chief of the community.† M. Moquin-Tandon supports his views by the details of experimental researches, by which he proves that each zoonite has really an existence independently of the others; inasmuch as, when separated from the others, it lived and died independently of them.

706. M. Dugès founded his general doctrines of morphology and classification upon these views of Moquin-Tandon. According to him, each lateral half of the segment of an invertebrate is a zoonite; hence, in the Articulata, they are placed, not serially, but biserially, in successive pairs. When arranged laterally, instead of longitudinally, they constitute the Radiata. Divide a Holothuria into five parallel strips, and you form an Asterias; unite the five limbs or rays of an Asterias by their contiguous margins,

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* *Op. cit.*, 2d edit. p. 197.

† *Ibid.* p. 202.

and you have an Echinoderm or Holothuria.* Integration of zoonites is more and more complete as organs are differentiated; but as integration advances, the life is more concentrated in the organism, and the independent vitality of the zoonitic elements is lost.

707. These general laws are of undoubted application to the development of the vertebrate organisms, and merit a more particular attention than they have received from physiologists and naturalists. They are capable of varied application, both to the form of organisms and the function of various parts. Thus, in the lowest forms of animal life, with simplicity of organisation there is equal simplicity of morphological law. The form varies with the uses to which the tissues are applied, and as they are constituted organs of vegetative or of relative life. Thus, in the Actinophrys and the Amæba, the entire animal is nothing more than an amorphous group of co-ordinated cells, of which the limits vary according to their functional relations to each other (250). When appropriate nutriment comes into contact with this co-ordinated group of cells, or with a portion of it, contractility is induced, and both a prehensive and digestive organ is forthwith constituted, the food being wrapped up, or closed in, as it were, by the cell-tissue. After being thus brought into immediate contact with the cell, it is modified by their vital forces and applied to their uses, so that they perform the functions of an absorbent and vascular system in the higher organisms, and carry on the processes of nutrition and repair as independently of vessels and nerves as plants. Hence the body of the Amæba—a jelly-like mass of cells—is at once an organ of prehension and intus-susception; of digestion, absorption, circulation, nutrition, reproduction, and co-ordina-

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* *Op. cit.*, p. 19, note.

tion (627). It is a *community of cells*, with similar endowments, co-operating together for the common ends of their existence—viz., their own maintenance, and the continuance in Time and Space of the society or socialistic species. This is the law with other low forms of animal-life, as the Sponges, Rhizopods, and Hydras, and also with corresponding evolutions of plant-life.

708. A higher mode of socialistic union is developed in the Polyzoa, the lowest type of the Mollusca, in which there is probably a common sac (the cœnœcium) for the aëration and circulation of the chylaqueous fluid, or nutrient material, which is kept replenished apparently by contributions of each polyzoon through the walls of its digestive cavity. Every one of these, however, has its own apparatus for the prehension and intus-susception of alimentary stuff (a mouth and tentacula), by which its digestive cavity is replenished.* Such seems to be also the principle of arrangement as to socialistic alimentation of the true Polypes, or Hydrozoa. But, with one or two exceptions, these societies or communities of animals have not the power of *moving* through space as a body; they are fixed like plants, and like them *extend* through space by growth. The *Cristatella Mucedo* (a polyzoon) is, however, an interesting exception to the rule. Its cœnœcium becomes a motor apparatus (674). "The entire colony," Professor Allman remarks, "is of an oval shape, convex above and flat below, where it attaches itself to neighbouring objects. Upon the convex surface are arranged the orifices through which the polypides emerge; they are placed near the margin, and run round the cœnœcium in three regular concentric series, which alternate with one another, and leave an oval space in the centre where

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* *The Fresh-Water Polyzoa*, p. 23. Ray Society's Publications, 1857.

no orifices exist. In the middle of the flattened under-surface is an oval disc, resembling the foot of a gasteropodous mollusc; by means of this disc, which is contractile, and admits of frequent change of shape, the colony adheres to neighbouring objects, or creeps on the submersed leaves and stems of aquatic plants."* This community of molluscs, thus moving about with the tentacula of its members extended, looks not unlike a hairy caterpillar. It is interesting to note, that the same kind of locomotive organ which is the characteristic of the individual mollusc, is also used by the compound animal. The means, however, whereby the polypides are co-ordinated, so that they shall move harmoniously, has not been ascertained, as no nerves have been discovered in the disc. It seems to be partly due to the continuity of the foot with the cœnœcium, out of which it is developed, and partly to the unifying action of the nutrient or lymph-like fluid it contains (674).

709. If we examine these social plant-like organisms from the teleiotic rather than the morphological point of view, and determine the order of vital events which constitute their life, with reference to the ends aimed at and attained, we shall find the analogy to the higher social animals is closer than appears at first sight. It must be remembered, however, in considering this matter, that *growth* and visible motion of organisms correlate each other, inasmuch as they are only different methods of attaining the same end (639). From this point of view, the formation of a protecting polypary for the ova of the hydrozoa by *growth*, or deposit of suitable matter from the tissues of the polype, is analogous to the instrumental construction of a nest or receptacle for their ova by the social constructive insects, out of materials col-

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* *On the Fresh-Water Polyzoa.* p. 79.

lected and elaborated by their appropriate organs. Again, in the alimentation of the young animal these social organisms show an analogy to the larva-stage of those insects in which the caterpillar or worm is self-dependent. The ovoid embryo of the Medusa, after moving freely through the water, and undergoing certain changes, is at last fixed, when it is differentiated into a series of alimentary apparatus (the polypes), each with its organs of prehension, digestion, &c., connected with the cœnœcium or common perigastric cavity. This is the analogue of the larval or alimentary stage of the insect; while the formation of the polypary corresponds to that of defensive construction by various materials gathered round the soft body. After the larva-stage comes that which corresponds to the stage of integration, preparatory to a higher development, which, in the Medusa, ends in the production of "buds" or gemmules in the polypary, to be finally evolved into true Acalephæ, but in the insect is the chrysalis-stage, preparatory to the adult life of the insect. In both cases, the series of cyclical changes again begins with the production of ova by the completed animal.

710. This differentiation of separate organs of the vital processes into distinct organisms attains its most remarkable evolution in the zoophytic animals, in the hydrostatic Acalephæ or Siphonophora. The Stephanomia, perhaps, is the most striking instance of this class. It is described as consisting of a stem or axis of flexible crystal, around which the viscera, as well as the organs of external relation of the animal, are developed. Each differentiation from the common stem is not, therefore, a generalised apparatus like the buds or polypes of the Corals or the Medusæ, which perform several functions. On the contrary, in the Stephanomia these functions are

specialised in special buds or offshoots of living matter, the analogues of polypes (springing from the stem); so that one "bud" seizes the food, and another digests it; a third carries on the aëration of the circulating fluid; a fourth is the seat of vision; a fifth bears the ovarium; and so on. The entire series of organs is intermixed around the central axis which co-ordinates them; and, finally, the whole colony has its appropriate organ of locomotion. This consists of a series of little bells, so attached to the central stem that their mouths are directed backwards. Then, alternately dilating to receive water and contracting to expel it, in the manner of a heart, they propel the whole community onwards.

711. Here, again, we find the same idea of the division of labour, for the better attainment of common ends, which is manifested in the social economy of the Hymenoptera, the bees and ants. In these one individual is charged with the function of nutrition, another with that of locomotion, another with that of production of the ovum, and so on. The difference is, that whereas the result is attained in the one case by an apparatus which grows and is fixed, in the other it is attained by an apparatus which grows and moves. Such, we have already seen, is the law in the methods for the protection of individual organisms from mechanical or molecular forces (659). In plants and in certain animals, the protective end is attained by structures that grow; in other animals, by moving instruments or self-moving organisms.

712. This plan of a physiological division of labour, in virtue of which organisms are on the one hand the analogues of viscera and organs of relation, on the other of highly-developed social individuals, is carried out in the different branches and sub-branches of organised nature, according to a general law of higher and higher

special differentiation and integration; and is manifested variously in them, according to the place assigned to them in creation. And it would doubtless be possible to found a zoological arrangement on this sociological law of development, and class animals in linear or correlative series, according to the modes in which the social system is carried out for the attainment of ends by combination.

713. But, in the first instance, we must trace up the same idea according as the end is attained, not only by the combination, but the integration of organisms, in virtue of which their individuality is wholly lost. Thus we have seen that, in the compound Cristatella Mucedo, an entire colony is locomotive as one organism; but it is only one in respect to a common nutrient material contained in a common nutrient apparatus, the cœnœcium, and a common locomotive apparatus, the disc-like foot developed out of the cœnœcium. As, however, we ascend the scale, and find that the external relations of a community multiply, so also the various apparatus for co-ordinating and combining into common action the units of which it is composed become more numerous and complex. Under these conditions, we find that a common circulating apparatus combines them into vital action; an elaborate locomotive system closely unites them in locomotion, and subserves the common business of the colony; and above all, by means of a differentiation and integration of the tissues, a special apparatus — the nervous system — is developed, which combines their various functions into unity.

714. A few illustrations will better show the operation of this teleiotic law of development. Beginning with the Helminthes, the lowest of the Vermes, the Tænia presents a colony of organisms in a chain which are simply sexual—the male and female without any organs

of prehension, but with a common motor apparatus in the continuous chain of muscles which connects them together, and with a common nutrient and vascular system. Here the young organism needs no protection of polipary or hive—no nurse or provider. Its habitat is the sheltered retreats it finds within the intestines and tissues of other animals, whose fate it shares, and within which it meets with abundant food ready prepared for absorption.

715. Ascending a step in the scale, we come to the Nemertes, an animal of the same kind as the Planaria. It is an errant worm, but parasitic, and lives, leech-like, by sucking the tissues of other animals. It has little need for an elaborate apparatus of prehension, motion, and co-ordination, since it rarely moves, and does not attack or pursue its prey with weapons. It is from thirty to forty feet long, only from five to six lines in width; is flat as a riband, and smooth and shining as varnished leather. In the absence of developed organs of relation, and of prehension and digestion, it may be considered as teleiotically homologous with a long composite biserial hydra (or rather polyzoon, since it has a nervous system), with its common stomach in line, and differentiated into a highly flexible body acting as an organ of prehension for the whole. Its nervous system is of the simplest form, and consists of two lateral ganglia situated near the æsophagus, from whence two nerves pass along the whole length of the body, each giving off small branches in its course. Two vessels accompany the nerve-cords, and one is on the medium line. Its mouth is simply a circular opening, scarcely visible, and opens into a long tube separated by a constriction from the intestine, which ends in a *cul de sac*, so that the mouth is also the anus. The reproductive power of the animal is as

energetic as that of the Tænia; often it is nothing more than an ovigerous sac, so that a Nemertes from eight to ten feet long will produce not fewer than four to five hundred thousand ova. In this animal we recognise the simple type of the molluscoid polyzoon—not muscular, yet capable of locomotion, and without any protective or defensive processes, or any social organisation. It is apparently a long contractile cell gliding through the water by means of excessively fine vibratile cilia. In its habits and structure, it is the boa constrictor of the *Vermes*.

716. In the *Branchellion*, a species of parasitic leech, first described by Rudolphi, found attached to the torpedo, we have a more highly organised communistic parasite. Its higher organisation demands a fitting aërating apparatus, adapted to the aqueous medium in which it lives and to the food it takes. Its rounded, spiral-shaped anterior extremity, or organ of alimentation, ends posteriorly in a body having the look of a violet-coloured leech, provided with a series of lateral appendages resembling thin laminæ, of a fan-like form; while another series, to the number of about two-and-twenty, are regularly partitioned and arranged in pairs, having at their base a hemispherical and semi-transparent enlargement. In each of these Professor Quatrefages found a kind of sac or *ampulla*, which dilated and contracted in the same regular way as a heart. And such, in truth, the structure is. Now, since the animal, like the Tænia, has no need of any organs of prehension or defence, the integration of its segments had led to the formation of that which it alone needed—namely, an apparatus (blood and lymph branchiæ) for aërating both the lymph and the blood. The pair-like arrangement of the hearts shows their segmental character.

717. But let us pass from the parasitic worms to those

that are at the head of the order, and have to fight their way in the world—namely the *Annelids*. The bodies of the largest consist of a numerous series of rings, each posterior ring being to a certain extent a complete animal, while the anterior are integrated into the head and organs of prehension and co-ordination. The annelid is in fact a longitudinal community of carnivorous organisms, having so little vital connection with each other, that those towards the posterior end may die, and even putrefy, without any apparent injury to those anterior to them. Their social character is indicated in various ways. First, their mode of reproduction is characteristic. On the first appearance of the embryo-annelid, it usually consists of a single segment, which is chiefly occupied by a large mass of unmetamorphosed germ-cells. This segment corresponds to the impregnated queen-bee, and its germ-cells to ova; for they "are not used up, as in higher animals, in developing the tissues and organs of an undivided or individual whole, but, after a comparatively slight growth and change of the primary segment, proceed, in the typical orders, to form a second segment of somewhat simpler structure, and then repeat such formations, in a linear series, perhaps more than a hundred times. So that we have a seeming individual annelid consisting of many hundred segments, in which a single segment would give all the characteristic organisation of such individual, except some slight additions or modifications characterising the first and last of tho series."*

718. A good example of this longitudinally integrated colony of organisms is presented by the *Eunice Sanguinea*, an errant annelid of frequent occurrence off the coast of Brittany (found at Brehat by M. Quatrefages),

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* Professor Owen. *Lectures on the Invertebrate Animals*, 2d edit. p. 252.

which is usually about two to two and a half feet long, and eight or ten lines broad. In the Indian seas, however, it attains the length of five or six feet. This Eunice is made up of about 300 distinct bilateral rings, each with its ganglion, giving off five nerves to each lateral half. The anterior rings are integrated into a mouth, œsophagus, and organs of prehension of a formidable carnivorous character; then each subsequent ring has its own stomach, which number for the entire colony about 280. So also each has its secreting apparatus and heart double—*i.e.*, one for each lateral half—so that there are above 225 pairs of branchiæ and 300 pairs of hearts, with their corresponding arteries and veins. While the rings are connected longitudinally with each other throughout by five pairs of muscles, each ring has its own pedal muscles, and thus locomotion is effectively provided for. In like manner each ring has its weapons of offence and defence, with their proper muscular apparatus. The Eunice is thus a community of warlike organisms, or a large carnivorous club, intimately co-ordinated for attack, or for the defence of the whole or of each of the parts.

719. But the Eunice does not manifest the highest development of the teleiotic social idea amongst the annelids. It is only the anterior members of the colony or club, integrated into a committee or council, that are provided with eyes and antennæ: these are in connection with the guiding centre of the whole,—the integrated ganglia of the anterior rings. In the Polyophthalmia, another errant annelid, each ring has its own pair of eyes. This is a cylindrical worm of a golden yellow colour, about an inch in length, and armed with two rows of setæ. It inhabits the Sicilian seas, sheltering itself in the sand, but pursuing its prey in the water. Professor Quatrefages thus describes the eyes of this animal:—"The Polyoph-

thalmia is provided on its head with three eyes, each of which is furnished with two or three voluminous crystalline lenses. Besides these, there appears on each side of the rings of the body a red point, very similar to those of the Amphicoræ. On dissection, we find that each of these points receives a large nerve issuing from the ganglion, or ventral nervous centre corresponding to it. By the help of the microscope we can see that this nerve penetrates into a mass of pigment, which incloses a spherical crystalline lens, and we now see that the textures lying before it have undergone a modification by which they are rendered more completely and equably transparent. In a word, we can no longer doubt that these red points, which are placed on the sides and along the whole length of the body, are true eyes, receiving their optic nerves from the abdominal nervous centres, and having no direct connection with the brain."*

720. This peculiarity of vision in the Polyophthalmia is interesting, as showing the true character of the organs of sight in the Articulata—namely, that they are differentiations of the outer general recipient tissue of the lower organisms; the fact is, however, more distinctly shown in the *Syllis*, an errant annelid of the German Ocean. When reproduction is about to take place in this animal, a number of rings become developed at the posterior extremity, the first ring being soon organised into a head provided with eyes and antennæ. It thus presents the singular appearance of two animals, united by skin and intestine; and, in fact, the newly-formed creature has apparently a will of its own, for the two sometimes struggle to go different ways! This new development is simply a self-moving, self-nourishing ovarium or testes; it corresponds in function to those

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* *Rambles of a Naturalist* (Translation). vol. ii. p. 180.

ciliated ovoid bodies that are given off by the Medusæ, and which are differentiated into polypods, with their reproductive organs, or rather to the queen-bee or drone, as the case may be. In a while the posterior Syllis is separated from the anterior, its body fills with eggs or with spermatozoa, and after a few days of individual liberty it bursts, the germs and sperms escape, and the parent animal perishes.*

721. The foregoing statements have chiefly reference to the differentiation of units, and their integration or combination into communistic organisms for the purpose of attaining the Egotistic ends of existence of the community, considered as an individual. But the general laws are manifested in like manner as to the reproduction of the species, and especially as to the alimentation and defence from external injurious agencies of the offspring, through its successive stages of development until it is differentiated, so as to aliment and defend itself by its own teleiotic agencies. Nothing is more striking than the immense variety of modes in which the parental instincts of social plants and animals are manifested,—nothing more striking than the unity of ideas. This is abundantly shown in the singularly varied methods of alimenting the young organism. We have already noticed some of the typical procedures adopted for alimenting and protecting the young in the lower organisms; in the higher, the business is an important department of the great system of maternal and paternal instincts, and is effected under the co-ordinating influence of the cephalic or anterior ganglia, as their 'organ.'

722. The general law of these instincts appears to be this, that in proportion as the organism is differentiated, and the nervous system evolved into a complexity of

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* M. Quatrefages. *Op. cit.*, pp. 216, 217.

parts, in the same proportion is the connection between parent and offspring both intimate and prolonged. Thus, while in the lower forms of plant and animal life even the ova and germs are free-moving organisms from the first, and seek their own sustenance independently of the parent (655); in the higher, they attain to considerable development before the severance occurs, or they are provided with food ready for use by the provident care, as it were, of the parent organism. The protection of the young organism from injurious mechanical agents, follows in like manner the law of defence of the parent organism. And here again we see that independent life and defence is manifested in proportion as we descend the scale. While the free-moving ciliated ovum of the Medusa, or the polyzoid mollusc, constructs its protective *cœnœcium* independently of the parent, in the higher organisms the protection is wholly derived from the parent.

723. It is, however, the more highly developed of the Articulata which afford the best illustrations of the communistic union of zoonites and animals to the ends of Life—namely, the maintenance of the individual and the species. In the lower Articulata and Radiata, these ends of existence are attained by the integrations of many units into one organism, and by the *physiological* division of labour amongst the members of the organism; but in the highest Articulata, the organisms (made up of units) are combined into societies, and the ends of existence are attained by *sociological* division of labour:—so that what in the lowest class are only the *functions of parts*, are in the highest *the duties of individuals;* what in the former are only vegetative processes, are in the latter instincts. In these respects, the Hymenoptera are, amongst Articulata, what man is amongst vertebrates. But man offers, in

one respect, a singular inferiority of power to them; for he has not yet attained to the knowledge whereby he can influence the production of sexes at will, so as to regulate the supply of that communistic labour which depends upon the relative proportion of the sexes. The result is, that, the conditions of production being equal, the number of each sex is nearly equal. This is otherwise with the bees. By apparently very simple modifications as to the quality and quantity of food supplied to a worker-larva, or imperfect female, and by an increase in temperature, they can develop the latter into a perfect female. On the other hand, they can induce the perfect female to lay worker-eggs or drone-eggs, according as the wants of the hive may require individuals to perform the duties of the husband, or the general defensive, constructive, and maternal duties of the community. This seems to be well established.*

724. Although the preceding illustrations of the operation of communistic laws are drawn mainly from the Articulata, it is right to state that they are as distinctly manifested in the Radiata. Thus the Echinoderms may be divided, like the Articulata, into two classes, according as the number of zoonites is definite or indefinite. Those with a definite number correspond to insecta—with an indefinite, to the annelids, as *Eunice*. Of this class the Ophuira and Luidia present the characteristics of the communistic organisms very distinctly. The rays (which are zoonites) abandon their common oral cavity, and scatter away from each other in the Luidia with the rapidity of children frightened at play. Professor E. Forbes has given an amusing description of the manner in which the

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* Leuckart, "Seebachen Studien," in the *Bienen Zeitung* (1855), p. 209; and Von Siebold, *On a True Parthenogenesis in Moths and Bees*, translated by William S. Dallas (1857), pp. 58, 64.

members that composed a gorgeous specimen of the *Luidia fragilissima* escaped him.*

725. The entire class of facts detailed in this chapter points conclusively to the general principle, that the consciousness in the entire series of animals, from the Invertebrata downwards, probably differs in kind from that of man and the vertebrates generally. Nevertheless we can conclude from them, that the great laws and needs of human society do not arise capriciously, but that they have their correlatives in the deepest and most primary manifestations of the laws of life and organisation. The highest evolution of what I have termed the Primordial Instincts is seen in the communistic instincts of the two classes of animals which are at the head of their respective archetypal branches; viz., the social insects, the most highly developed of the Invertebrata; and the social man, the most highly developed of the Vertebrata; in both, the family instincts constitute the solid foundation of society. Hence it is that in proportion as they are active in a nation, in the same proportion its social organisation is vigorous and complete (500).

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* "Whether the cold element was too much for him, or the sight of the bucket too terrific, I know not; but in a moment he proceeded to dissolve his corporation, and at every mesh of the dredge his fragments were seen escaping. In despair, I grasped at the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision."—*History of Star-Fishes*, p. 138.

CHAPTER IX.

THE PHYSIOLOGY OF THE CORPOREAL FEELINGS AND DESIRES.

SECT. I.—*The Modifications of the Cœnæsthesis.*

726. THE conscious enjoyment of existence, or life, may be considered as the first dawn of self-consciousness; although in lower organisms it is probably nothing more than a simple feeling. Enjoyment of life is one of the objects aimed at in the law of design; hence, according to the law of consciousness already established (361), a *desire* for this enjoyment necessarily coincides with the teleorganic changes going on to that end. In like manner, since continuance of the organism is aimed at in the law of design, so continuance is necessarily aimed at by the organism, and desired, if it be endowed with consciousness. This is the instinct for life as a vital Energy (279), and the love of life as a Desire (363).

727. The primary form of the desire thus defined is limited to a purely corporeal sphere in the lowest conscious organisms, and need not therefore include any derivative desires having reference to things of external relation. The state of consciousness will consequently depend primarily upon the state of the viscera and the blood. When the processes going on in these are in teleiotic combination, and fulfil the ends of their construction, all the teleorganic changes in the nervous system (if that be normal in structure) will be performed

according to the plan upon which the organism is constructed, and thereby the object of that plan—viz., the maintenance and well-being of the organism—attained. In man, the correlative mental condition of the "concrete *Ego*" of this normal state of the vital processes is that which is indicated by the words Ease, Comfort, Feeling of Health, Good Spirits, Enjoyment of Life. When the organs, or any of them, fulfil their functions imperfectly, so that the processes necessary to the well-being of the organism are not perfected, then a state of the consciousness is experienced, indicated by the terms Disease, Discomfort, Feeling of Illness, Low Spirits, Irritability, Loathing of Life. The state of consciousness in either case has been designated the feeling of existence, consciousness of existence, general sensation, the corporeal sense, the *cœnæsthesis*, or *cœnæsthesia*, κοινη ἄισθησις. The feeling of the moment is the sum of the corporeal feelings, whatever those may be.

728. Now, when the encephalon is highly differentiated, and the vital processes therein are very active, there is very little of this corporeal state of consciousness experienced. The results of the encephalic processes—the thoughts—are usually so much more vigorous than of the merely vital processes, that they pre-occupy the man, and he becomes even wholly unconscious of his corporeal existence. When this activity is highly developed, as in forced acts of attention, whether in active effort, as on the field of battle, or in deep thought, or in mesmeric and biological processes, the most severe injuries to the body may be wholly unfelt, until the encephalic action ceases or abates. This condition may be termed *Anæsthesia*.

729. Far otherwise is it when serious derangement of the functions of the viscera and blood takes place, or an important injury is inflicted on the body, while no exces-

sive encephalic action is going on. Then all the symptoms of an acute disease suddenly attacking an individual, as a fever or inflammation, are manifested. Corporeal pain is felt either locally or generally, and the corporeal sense of ease is changed into that of disease. This preoccupies the man, so that mental attention or thought is difficult, if not impracticable. Various sensations, appetites, and desires arise, of a morbid character. The head aches, the limbs are weary, the muscles soon become the seat of the pain of fatigue, especially those of the back. The respiration is hurried, the heart's action quickened, or depressed, or otherwise altered. The natural temperature changes, the body being now hot, now cold. There is thirst and loss of appetite, or morbid appetites, and imperfect action of the eliminating organs, so that the skin is dry, the bowels sluggish, the urine scanty. Especially does the great co-ordinating and combining apparatus suffer, so that neuralgic pains, hallucinations, troubled dreams or sleeplessness, delirium, convulsions, just according to the circumstances of the individual, are amongst the phenomena developed. In this condition there is a state of perversion of the feelings, which may be termed *Paræsthesia*.

730. When the general disturbance is purely functional, and especially if the nervous system be not too deeply involved, the contingent primordial instincts, or the Psychal Instincts proper (620), come into action in these morbid states; and after a while there may be a cessation of disease and disorder, and a return to the healthy condition. And this law applies equally to the reparation of mechanical or other injuries and to the modification of morbid states of the blood or the viscera. In this way it is that certain diseases are termed *acute*; the word meaning, that the morbid state ends in a few days or

weeks, either in comparative restoration to health or in death.

731. This natural tendency seen in organisms to repair injuries, whether it be the loss of a limb (as in many of the lower organisms), or to heal a wound or unite a broken bone in the higher, has had much discussion. The law itself has been as generally recognised as the archetypal or absolute law of Life and Organisation; and the phenomena have been attributed to the operation of a teleological power or force, variously termed, from the results attained, the *vis medicatrix* or *vis conservatrix naturæ*, the *archæus*, &c. We have seen that the *lex nostri conservatio* is one of the fundamental laws of life, and this restoration to healthy action is but one of the many manifestations of that law: further we need not inquire. What concerns us to comprehend is the course of the events by which order and ease are evolved out of disorder and disease; or, in other words, the immediate causes of restoration to health.

732. The causation of these phenomena, or the general order in which they co-exist and follow each other, is easily comprehended after the full exposition I have already given of the reciprocal relations of the viscera to the blood, to the nervous system, and to each other. In the majority of diseases, we take the blood as the principal, though not the sole starting-point; for in all diseases, con-causes, and not simple causes, are operative. A functional disorder of a viscus may predispose the blood to take on morbific action, by causing failure in its eliminating powers; but this failure may be due, in its turn, to imperfect functional activity of the nervous system, or some portion of it; and this morbid state of the nervous system may again be a cause of disease, by rendering that system susceptible of morbid blood-

changes, which otherwise would be too slight to develop the *sensible* phenomena of disorder, which we term Disease. Thus, causation occurs in all diseases in a complex way. Nevertheless, as we must begin the inquiry at some one link in the chain, the best link, in the majority of cases, is the condition of the blood.

733. These doctrines are only intended to apply, however, to the blood in its own vital relations, and considered as itself constituting an organ, but not to the moving powers of the blood; that is to say, to the appropriate distribution of the fluid. The relations of the heart and blood-vessels, as the principal moving powers, to the nervous system, and through that to the various states of consciousness, will constitute an important part of our inquiry, to be taken up separately. This fundamental doctrine being admitted and comprehended, we can apply it to the causation of states of cœnæsthesis. The blood is alive, and is an apparatus of fluid flesh, made up of cells or corpuscles, having vital forces analogous to those of other cells or corpuscles of the organs, floating in the nutrient fluid, which carries them to the various tissues. There they act affinitively at the same moment both upon other cells and upon the fluid within which they float; and thus the corpuscular phenomena of life go on. Now, as adaptation is the fundamental law of life, so it is the fundamental law of these corpuscles in or by which the blood acts so general and important a part, especially as it flows through the nervous centres and nervous system generally. The tissues of the body are built up of various materials, all of which are supplied from the blood, and which are deposited from it in the localities required, according to the archetypal plan of construction; so that, under the mutual action of these blood-corpuscles and the corpuscles of a part, whether of the nerves or not, acting according

to law, sulphur is deposited here, in the skin; lime there, in the bones; phosphorus, throughout the brain; carbon, in the pigment-tissues; albumen or protein-compounds everywhere, in their proper proportions. And when the used-up materials have to be eliminated, or noxious things that have got into the blood expelled, there is a similar process instituted. The excreting cells of the various excreting organs perform, in relation to the blood-corpuscles, the function allotted to them; and bile, urine, and various gases, composed of nitrogen, hydrogen, carbon, phosphor, sulphur, are eliminated as excretions.

734. Since these relations of the blood to the functions and corpuscular elements of organs undoubtedly extend to those of the nervous system, there is going on within it the same play between its corpuscular elements and those of the blood as in other organs; that is to say, with an appropriate supply of nutrient materials, there is a stimulation of the nerve-centres to the appropriate performance of their functions, in relation to the composition of the blood, and to the other conditions necessary to the corpuscular processes of vegetative life. Now, as a proper warmth, a due supply of oxygen and a due supply of fitting materials, are necessary to these processes, so it is the condition of the blood, as it circulates through the nervous system, which regulates the action of the nervous system in its relations to the desires for warmth or coolness, air, water, and the various alimentary materials. Any excess or deficiency in these requisites will be signalled by the appropriate sentinel-apparatus, as the blood flows through it, and the appropriate appetite will be felt. In this way, we clearly see that an appetite is connected with changes in the nervous system which are entirely analogous to those connected with corporeal pain; like that, they are sentinel-feelings.

735. Returning then, to the cœnæsthesis, or general corporeal feeling, we can now understand that this will vary as the conditions of the circulating fluid vary. The general feeling is that of health when the conditions are healthy, and there is also a healthy condition of the nerve-centres, so that the functions of both are healthily performed. On the contrary, when the general feeling is morbid, the various functions are performed unnaturally and unhealthily, for the laws of life are broken. It follows, therefore, that a morbid general feeling is necessarily associated with almost all diseases of the blood. It is the premonitory stage of all acute diseases, whether fevers or inflammations, and of a great variety of chronic affections. In particular, it is an accompaniment of these visceral diseases by which the nutrition, oxygenation, and depuration of the blood are rendered imperfect. All these changes influence the nervous system through the blood, and, by the changes they operate therein, modify painfully the states of consciousness of existence—causing not only corporeal pain of all kinds, but the feelings termed Depression of Spirits, Irritability, Melancholy, and the like.

736. There are, however, states of the blood really morbid, insomuch as they are departures from healthy states; as there are also of the nervous system, the viscera, and the tissues generally, in which the result is not a painful depression of the cœnæsthesis, but is either a pleasurable exaltation or at least a state of indifference. The latter is a form of *anæsthesia*, the former may be termed *hyperæsthesia*. Sometimes this exaltation is a cheerful hope and joyousness, contrasting strongly with the really diseased state of the body. This class of cœnæsthetic states is very commonly misunderstood by non-professional persons; and even able practitioners,

whose attention has not been particularly turned to medical psychology, are apt to mistake the meaning of this morbid state of the cœnæsthesis, and entertain favourable hopes of a patient's recovery, when, in truth, it indicates a really hopeless case.

737. The causes of these states are situate usually in both the blood and the nervous system. In those in which there is a cheeriness or hopefulness, as in cases of phthisis or pulmonary consumption, and other pulmonary diseases, the feeling may be due to some constituent morbidly developed in the blood itself, acting like alcohol and other similar agents on the nervous system; and there may be such a slight functional disturbance—amounting to an erethism of the nervous system itself—that the morbid states are just sufficient to modify it, so that the changes normally associated with that state of general feeling are induced. This is especially likely to occur in pulmonary consumption, since the lungs, through the pulmonary branches of the *vagus*, are intimately related to the *medulla oblongata*, the centre of vital consciousness. The state is termed *Euphoria.*

738. *Insane Joyousness* (Amenomania—Chairomania) is occasionally met with in asylums. It consists in imperturbable good-humour. The pathological conditions have not been investigated; but it is probably analogous to euphoria, and only differs from it in the larger extent of nervous centre involved. Transient forms occur, as in intoxication, from the action of poisons introduced into the blood, and thence operating on the encephalon. The "laughing gas" is the most striking, in its operation, of this kind; but alcohol, ether, wine, have the same effect. There are also vegetablo poisons, such as belladonna, hachish, and opium, with the same powers.

739. This hyperæsthesis of the feeling of healthy exist-

ence appears to be due essentially to the same kind of causes as pain itself, only they are operative in a less degree. It consists simply in an increased activity of the vital forces, sufficient to stimulate the tissues pleasantly and within limits; whereas painful states supervene when the stimulation has been excessive and the vital powers exhausted. Hence, any stimuli to the vital forces may serve not only to cause the pleasant feeling to arise when the state of consciousness is one of indifference, but also to convert the painful into a pleasurable cœnæsthesis. Thus, wine gladdens; food raises the spirits when depressed from long fasting; and good nutrition cures mania or melancholia brought on by deprivations. In this way, free exposure to the sun and air in nature, climbing the mountain-side, wandering along the sea-shore or by the babbling river, soothe the nerves and reanimate the spirits, if depressed and wearied, or give more vigour and joyousness to cheerful, vigorous life.

SECT. II.—*The Morbid Modifications of the Appetites and Desires.*

740. In morbid states of the cœnæsthesis the corporeal appetites are rarely unaffected, so that there is often some important modifications of the desires for food, drink, air, &c. I have already used the term *orexis*, derived from Aristotle (386), to indicate desire generally; and since these modifications of it are fundamental, and follow the same laws of modifications of the corporeal feelings, it will be useful to place it in the same category as *æsthesis*. We can thus designate that state of the cœnæsthesis in which there is an entire cessation of desire, *anorexia;* that in which there is a perversion, *parorexia ;* and that in which there is an exaltation,

hyperorexia. The latter term would serve to designate a morbid exaltation of any desire, or of the desires generally, beyond the usual condition of the individual; while *parorexia* would indicate unnatural (and usually degrading) appetites. Under the same head all the so-called "lusts" must be included.*

741. The cœnæsthesis undergoes various modifications, as to both the feelings and appetites, in various forms of diseases of the viscera, in which, conjointly with impaired function, there is often a morbid state of both the viscera and the blood. This class of morbid states of the consciousness are mainly grouped under two names—namely, *hypochondriasis* and *hysteria.* In the former, the morbid condition is referred to changes in the abdominal viscera; in the latter, to changes in the pelvic viscera. In both, there is usually a morbid condition of the blood, and commonly in consequence of imperfect elimination of some of the *effete* products of the vital processes. I long ago pointed out the connection of both hysteria and hypochondriasis with various morbid conditions of the blood, but especially with that which is due to the presence of the *materies morbi* of gout, and designated the general state *Neuræmia.*† In short, I showed that these diseases were sometimes irregular forms of gout.‡

742. The influence of periodic changes (687), and of

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* The word *kinesis* was also used by Aristotle in a definite sense, and may be applied, like *orexis* and *æsthesis*, to indicate muscular movements and their modifications. Thus, *akinesis* signifies deprivation of motor power; *hyperkinesis*, excessive motor activity, as in tetanus; and *parakinesis*, perversion of muscular action, as in chorea.

† *Treatise on the Nervous Diseases of Women*, p. 84; and chap. v. part ii., "Relations of Nervous Diseases to Alterations in the Composition of the Blood."

‡ *Op. cit.*, p. 161.

stages of development, is strongly shown in all this group of morbid states. And it may be stated generally, that true hysteria occurs most commonly at the evolution of the generative organs, or when they are undergoing undue excitement; hypochondriasis first shows itself with the involution of these organs, or when they are enfeebled from excessive use.

743. In the two classes of morbid states, the symptoms vary very much. In hysteria, there is a state of hyperæsthesia, amounting to great sensibility to impressions of all kinds. Paræsthetic sensations are not uncommon as to feelings of temperature, touch, and injuries of the body. The alimentary appetites are either abolished, or (more commonly) are paræsthetic, so that dietetic longings and caprices, *pica*, *bulimia*, and the like, are manifested. Sometimes there is hyperæsthesia as to the sexual appetite, occasionally developed into nymphomania; sometimes highly morbid states of the relative feelings and sentiments arise, together with their representative phenomena, as laughter, sighing, weeping, &c.; and not unfrequently monomaniacal impulse for lying, stealing, killing, &c. Hysteria is, in truth, a transitional state to insanity in various forms.

744. In hypochondriasis, the feelings that are developed are rather personal than relative, as in hysteria. There is, however, the same class of paræsthetic sensations, and imaginary pains and impressions are common. More commonly, however, there are delusions, rather than the deceptions of hysteria, as to the state of various viscera, and the patient concentrates his anxious attention either upon some of them, or upon the state of his health generally. When the Egotistic feelings are morbidly developed (480, *sqq.*), the disease is termed *Melancholia.*

745. This general morbid condition of a higher form

of evolution of the cœnæsthesis has been termed *Phrenalgia* by Professor Guislain.* It corresponds to melancholia and hypochondriasis. It may be said to include all forms of painful modifications of the cœnæsthesis in which there is doubt, fear, apprehension, or other depressing emotions. The most general form is that undefinable fear of injury which has been termed *Pantophobia.* It is a leading symptom sometimes in both hysteria and hypochondriasis; is not unfrequently seen in young children with cerebral irritation; and is a symptom of morbid dreaming in *sleep,* as when patients rush out of bed in a vague terror; or in nightmare, as a symptom of a morbid condition of the blood circulating through the vital centres (imperfect aëration), or of a morbid distribution of the blood (heart-disease, full stomach). It is also a form of *delirium* in fevers. Fever-patients are apt to leap out of a window, or fly in terror, under a sudden impulse of this kind. And it is sometimes the exciting cause of sudden or impulsive *homicide.*

746. *Anæsthesia of the Egotistic Feelings,* or *General Apathy,* is that state of the consciousness in which there is an indifference shown towards things desirable or injurious. In its primary form, it is shown in the cataleptic state, and in the volitional paralysis of hysteria; not unfrequently it is a leading symptom in what has been termed *Phrenoplegia,* a state in which the individual has been suddenly struck with general anæsthesia of the desires and feelings; it is also the chief characteristic of *dementia.*

747. *Indifference to life* is often seen in both acute and chronic diseases; and is by no means an uncommon characteristic of disorders of the blood and nervous system. It is seen, as a singular apathy, very remarkably in some of the worst cases of epidemic cholera, even before the stage

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* *Leçons Orales sur les Phrenopathies.* 1852.

of collapse sets in. It is also shown in advanced stages of typhus, and in epidemics of plague and the yellow fever. In diseases in which the nutrition of the blood is seriously impaired, as in sea-scurvy, in famine-struck people, in gangrene, and in long-continued visceral diseases, it is not uncommon. When it supervenes upon a state of anxiety about the health, it is a significant symptom of a dangerous disease.

CHAPTER X.

PHYSIOLOGY OF THE APPETITES.

748. The general doctrine as to the desires being established, it will be useful to examine in detail the physiology of some of the leading corporeal appetites. We shall thereby more distinctly comprehend the relations between states of the blood and tissues on the one hand, and of the nervous system and the consciousness on the other. With the view, however, of restricting the inquiry within convenient limits, I shall confine it to the appetites which are derivatives of the primordial instincts for dynamisation and alimentation (618).

749. *Appetite for Light—Light-Hunger.*—Attempts have been made to determine what particular kinds of rays are most favourable to life. The heating rays are essential (677); for it is certain, that while the inhabitants of dark caves exist without light, it is not probable they can exist without heat. Perhaps, in the combination of both we have the most effectual stimulus to vital action; for the luminous rays are necessary to the proper development of plants and animals. This is fully shown by the well-known experiments of M. M. Edwards on tadpoles; he found that when they were deprived of light they did not undergo their proper transformations, but, remaining tadpoles, increased to double or triple their ordinary size.*

750. The vital influence of light, as a chemical force,

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* *De l'Influence des Agents Physiques, sur la Vie*, p. 400.

is shown most strikingly by the changes in colour which it induces in plants and animals. In plants, light enables the organism to decompose carbonic acid, and to fix the carbon; and it seems to be established, that the yellow rays (which have the greatest illuminating powers) are the most effectual in giving colour to plants, as well as in securing carbon. Morren, Daubeny, Draper, and Gardner, say that the yellow rays have the greatest effect in producing chlorophyle, as well as in deoxidation.*

751. From a series of experiments made by M. Moleschott on frogs, he drew the conclusion that the light of the sun, as distinguished from its heat, increased the production of carbonic acid in animals, and consequently the elimination of the carbon, about a fifth.† It is probable, as Liebig surmises, that the carbon deposit in the skin and hair of man is vicarious to pulmonary excretion, but I think it is vicarious in some cases with urinary excretion also.‡ Certain it is that the eliminating function of the skin in the dark races is very considerable, and that much carbon must be given off both by the hair and *rete mucosum*. It is probable that to this cutaneous action is due the almost entire exemption from the influence of the fever-poisons of tropical climes, as those of malignant, remittent, and yellow fever, possessed by the dark races,

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* Draper, "Chemistry of Plants," p. 61; *Phil. Mag.*, 1840. vol. xvi. p. 81. Daubeny, "On the Action of Light upon Plants;" *Trans. Brit. Assoc.*, 1833, p. 436, and *Phil. Trans.*, 1836, p. 149. Gardner, "On the Action of Yellow and of Indigo Light on Plants;" *Phil. Mag.*, 1844, p. 1. Quoted, Profesor Balfour's "Class-Book of Botany" (1854), p. 487.

† *Comptes Rendus*, vol. xli. (1855.)

‡ The reasons for this opinion are almost wholly pathological, and are drawn from the pathology of pigment-deposit in various forms of disease. They are given in my systematic course on the Practice of Medicine.

and which are so destructive to the white until acclimatization is completed; and even then the protection is comparatively imperfect.*

752. That the heat and light of the sun has a powerful indirect influence upon the ethnic characters of mankind, as well as upon the instincts of animals, is certain. The nervous irritability and sensibility of the Asiatic seems due mainly to this source; and probably the instincts for food, drink, bodily exercise, and the like, are fundamentally modified by them. In the tropics, where the sun's light and heat are at their maximum, all living things attain their *maximum* development, so far as their corporeal or merely vital forces are involved; while, on the contrary, in the dark and gelid polar regions, they are for the most part at a *minimum*. Whales and polar bears are not an exception, for these are not exposed to the extreme degrees of cold of a polar winter. Man, like other animals, attains to great perfection and beauty of form in the sunny regions of the earth, provided he has a sufficient supply of food. Hence travellers remark constantly upon the extreme beauty of form of the coloured races, both of Africa and America. Amongst the tens of thousands of Indians of all tribes which Humboldt saw in South America, there was hardly one deformed. "Deformities and deviations from the beautiful in form," he remarks, "are infinitely rare in certain races of mankind, particularly those in whom the cutaneous system is deeply coloured. I cannot think that they depend entirely upon the progress of civilisation, and of luxury, and the corruption of

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* Of 7890 black African emigrants resident in Guiana when the yellow fever lately prevailed there, not one was attacked.—Dr Blair, "Report on Yellow Fever," *Med.-Chir. Review*, vol. xvii. (1856), p. 80.

manners."* It must be remembered that these races are naked, and therefore fully exposed to the sun's rays. Since, for the most part, the dweller within the tropics has little war with the elements, as compared with the inhabitants of less favoured climes, and the teeming earth requires comparatively little labour to give forth what he needs for his existence, that struggle with difficulties, which both exercises and develops the mental faculties of man, and which is the solid and sure ground of progressive perfection (310, 311), is not the lot of tropical races.

753. The growing towards the light of plants, and the desire for light of animals, are both due to the same fundamental law. It is a seeking after the stimulus of force (618), as the first requisite for the continuance of life. Basking in the sun, therefore, is one of the chief pleasures of many animals, and of not a few races of men. The ancient Romans believed it made the skin delicate. "What is your chief good?" asks Persius. (*Sat.* IV.) "To have lived always on rich dishes, and a skin made delicate by basking in the sun." The "apricatio," or sunning of themselves, was a common practice with old Romans. Juvenal refers to this practice in his 11th Satire (to Persius).

754. *Appetite for Warmth and Coolness.*—In hot countries, there is a desire for abstraction of heat, or coolness; in temperate climates, in which the heat of the sun is less intense, and artificial heat has to be provided during the winter, there is a desire for additional heat. The body of man must be maintained at a proper temperature, however high or low that of the surrounding atmosphere may be. This is from about 94° to 96° Fahr. Any wide departure from this standard is followed by disorder of function, alteration of structure or of nutrition, and death. A too low temperature is the cause, in temperate and

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* *Voyage aux Regions Equinoxiales* (Paris, 1814), p. 471.

arctic regions, of a large number of diseases; in tropical countries, this is the case with a too high temperature.

755. Since the temperature of the external atmosphere has a wide range, there is a need in the organism for a vital self-regulating thermometer, and for a ready means of increasing or diminishing the heat of the living tissues as may be required,—especially of those most exposed to the variations of atmospheric temperature—the lungs and the skin. Now, when the animal heat rises above the healthy point more rapidly than it can be diminished, a painful feeling, termed Hotness, Heat, or Burning, is experienced; if, on the contrary, it sink more rapidly than it can be increased, a painful feeling, termed Coldness, Chilliness, Shivering, arises. In either case, a desire accompanies the feeling for less or more warmth, as the case may be. If the excess of heat be abstracted, a pleasant feeling is experienced, termed a refreshing or pleasant Coolness; if the want of it be supplied, the feeling that arises is that of a genial or pleasant Warmth.

756. These sensations are felt obscurely in the stomach; more obscurely upon the intestinal and other internal mucous surfaces; hardly at all upon the pulmonary mucous surface; very acutely upon the surface of the body. The exemption of the lungs, since their air-surfaces are exposed naked to the air, may be taken as a proof that there is a power of rapid evolution or diminution of heat in them: a man can breathe the high temperature (as Chabet, the "fire-king," did in an oven) of 400° to 600° Fahr., or pass immediately from breathing air of a temperature of 50° Fahr. to breathe air at $-50°$ (as has been done by Arctic explorers), and yet experience no sensible injury, or even great discomfort.

757. The temperature of the organism is regulated by various methods. Thus, in certain plants, at the time of

fertilization (as in the Arum), an increased temperature is kept up. Numerous flowering plants cover up the genetic organs with the sepals and petals when the sun sets, or even during the day if it is obscured by clouds. Animals exposed to seasonal variations in temperature undergo corresponding changes in the tegumentary coverings, one of the functions of which is to retain the heat of the animal. Hence wool, hair, feathers, down, &c., are developed variously in various animals, or fat is deposited immediately beneath the derma on the approach of winter. In the hybernating animals, the instinct to provide against cold is developed presciently, and winter dwellings are constructed. In like manner, the migratory instinct impels the migratory animals to seek warmer or cooler latitudes, as may be needed, according to their powers of adaptation to variations of external temperature.

758. The human skin being naked, is peculiarly sensible to increase or diminution of atmospheric heat. This quality has obviously a direct relation to the instinct for heat, and of defence against the abstraction of it from the body, or cold. Sir William Hamilton and others have suggested that there is a class of nerves having the function of discriminating changes in temperature; and Professor Virchow entertains the very probable opinion that there is a special ganglionic centre for the regulation of the heat of the organism. That something of the kind is needed, is shown by the fact that a persistent high temperature follows section of the sympathetic in the neck, in the corresponding side of the face. In man, as well as in other animals, the temperature is kept at the normal standard by a simple process. The cutaneous vessels pour out water, and the evaporation of this cools the body. A similar process provides for the normal temperature of plants. Hales computed the perspiration

of plants to be seventeen times more than that of the human body.

759. The appetite for heat in man, and for the protection of the body against the loss of it, is primordial. It is the incentive to all the useful arts, both textural and architectural, by which he protects himself from meteorological changes; and to all those laborious commercial and agricultural pursuits by which he procures the inorganic and animal and vegetable materials that he works up into dwellings and clothing.

760. Thermal feelings are induced from changes in the nerve-centres, when there is no corresponding change in the tissues. Burning feelings or hot feelings, and the contrary, on the skin and inner surfaces, arise as neuralgic or hyperæsthetic affections. In fevers, the thermal feelings do not necessarily correspond to thermal changes—often when coldness is felt, the body is actually *hotter*.

761. *Air-Appetite.* — Every organism requires a due supply of the atmosphere for the proper performance of its functions, according to the plan of its construction. The necessary chemical changes, and the transferences and expenditure of force, cannot go on, nor can the temperature be kept up, without it. If in warm-blooded animals the supply is cut off from the lungs, even for a few moments, the blood becomes carbonised, and a distressingly painful feeling is experienced from its action in the nervous system, termed Feeling of Suffocation, or Want of Breath. Therewith an urgent desire, together with a violent effort, to breathe the atmosphere, arises. This appetite is not in truth stronger than that for food or drink, but it is more commonly felt and is more urgent, because it arises so easily and rapidly. When the supply is suddenly diminished in a comparatively healthy individual, as in drowning or strangulation, or in spasmodic

asthma, croup, and bronchitis, or in certain diseases of the heart, the appetite becomes very urgent, and the efforts to gratify it excessive. When it is gradually diminished, and the vital actions are coincidently diminished also, as in lingering pulmonary consumption, there is often little or no appetite experienced, only automatic hurry, termed *shortness* of breath.

762. In cases of this kind, even although there is no *feeling* of want of breath, but nevertheless pulmonary congestion, or other disease diminishing aëration, exists, and the breathing is hurried, an automatic moaning and groaning is often uttered during sleep, as if expressive of great pain and distress. Sometimes the patient moans so loud as to awaken himself from a sound dreamless sleep. This noise is just as automatic as the hurried breathing, and is evidently due either to the action of the morbid lung on the *medulla oblongata*, through the afferent nerves of the *vagus*, or else to the carbonised blood circulating therein.

763. The skin in the Articulata is the aërating organ; in Batrachian reptiles, it is in this respect supplementary to the lungs. In man, this primordial mode of aëration is probably sometimes the source of peculiar actions. A person dying of pulmonary disease, lying on his back, and breathing with the utmost difficulty, yet wholly insensible to impressions, continually throws off the bedclothes, so that the skin may be exposed to the atmosphere. In this state, as in many others, whatever may be the object of the acts, feeling is not a cause of them. They are wholly reflex and automatic, and induced by the morbid states of the blood or viscera which immediately precede death.

764. *Thirst, or the Appetite for Water.*—The body consists of 66 per cent. water. In the brain there is 80 to

84 per cent. When the normal quantity is diminished from any cause, or when the matters held in solution in the blood are normally increased, or when some of the vital processes are unusually active (especially in disease), and there is need for more fluid, an unpleasant or painful feeling is referred to the throat, and a desire arises for water. This constitutes, in a slight degree, the *appetite* for water; in a more intense degree, it is *Thirst.*

765. Water is an essential element in the construction of all organisms whatever. Hence many have a vital hydrometer as well as thermometer, and means for storing up water for the uses of the organism, more or less complex, or, when too abundant, of eliminating it rapidly. Both plants and animals furnish numerous illustrations of the variety of constructive plans manifested in organisms, with a view to this end. In man, a ganglionic centre is probably the seat of the hydrometer; and consequently a morbid state of that centre may either develop the desire when water is not needed, as in nervous thirst (*Polydipsia*), or prevent the necessary changes taking place when it is really needed, as in the later stages of typhus and other fevers (747). The desire for fluid is often medicinal, as in the early stages of fevers and inflammations, and perhaps after severe injuries or shocks to the nervous system.

766. Deprivation of water can only be borne by man for a brief period. Want of it causes so much more suffering than want of food, because the nervous system itself, requiring so large an amount of fluid for its structure and function, is the first to suffer when the supply is defective. Prolonged deprivation tends to develop great functional disturbance of it, but particularly maniacal excitement, and a wild, uncontrollable desire for water.

767. Fluids containing alcohol have been taken immemorially as substitutes for water. When drunk in moderate doses, they act as direct stimulants to the nervous system. But if care is not taken, a habit is formed in this way, and then the feeling of thirst which arises when they are not taken, is sometimes almost as intense as the thirst for water under the same circumstances. This, when irresistible, is termed *Oinomania*, or *Dipsomania*. Such habits may be transmitted hereditarily and re-appear in the offspring. This probably occurs even when the habit in the parent has not been carried to intoxication.

768. *Hunger, the Appetite for Food.*—Every organism is so constructed that certain combinations of the elementary forms of matter, more or less complex, must be constantly supplied to it (611). These constitute the proper food of the organism. The materials constituting the food are either taken up with the water received into the organism, and absorbed by the vessels or tissues; or in a more or less solid form, when it is subjected to a series of processes of trituration, disintegration, chemical analysis and synthesis, &c., previously to the final elaboration into blood. When a need for new elementary materials in the blood and tissues occurs, a painful feeling is experienced in the stomach or region of the stomach, and of Lassitude, or feeble muscular and vital power. Concurrently with this feeling, a desire is felt for that kind of food which is appropriate to the organism. If in a slight degree, these changes in the consciousness constitute the *appetite* for food; if in an intense degree, *Hunger*.

769. It is popularly supposed, that the cause of the *feeling* of hunger is in the emptiness of the stomach; but this to a certain extent is an error. The painful feeling in the region of the stomach is probably due in great part

to the emptiness of the stomach, inasmuch as, for the due performance of its functions, that viscus should be filled so soon as it is emptied. But the *desire* for proper *food*, and the associated feelings of languor (conjointly, hunger), are chiefly if not wholly due, like other feelings of this class, to changes in the ganglionic centres appropriate to that particular and anticipated condition of the organism, the consequence of the changes in the blood which result from a cessation in the supply of aliment. This is conclusively shown by those instances of abdominal consumption, mostly met with in children, in which disease of the mesenteric glands constitutes a mechanical obstruction to the flow of the chyle through the chyle-ducts, and so cuts off the supply of nutrition to the blood. Now, in such cases, the appetite for food is intense, and the hunger great even when the stomach is filled with food. Nothing can be more characteristic of the phenomena consequent upon the urgent desire for food than the actions of a child thus diseased, and whose appetite no amount of food will appease. On the other hand, alimentary *anorexia* will and does occur constantly when the stomach is quite empty, as in fevers, inflammations, and most acute diseases. This seems to be teleiotic in its character; for since digestion and chylification are interrupted, and no muscular activity takes place, food would only be embarrassing until the curative process is completed. Then, it is found, the desire for food returns, and therewith the viscera return to their healthy function. Hence, it is of very little use pressing much food on the patient when *anorexia* is thus set up in diseased states.

770. *Bulimia*, or alimentary *hyperorexia*, is due, however, in some instances, to the epigastric sense of emptiness which is experienced when the stomach, from any cause, is unusually distended. In these cases, there is felt an

urgent need to fill the stomach, so that the morbid appetite is proportionate to its morbidly-increased capacity. But then, on the other hand, even this kind of *bulimia*, like *polydipsia*, or nervous thirst, will arise from morbid states of the nerve-centres, independently of the state of the stomach as to distension or fulness.

771. *Special Alimentary Appetites.*—The needs of the organism require, under varying conditions, different kinds of material, whether solid or liquid (675). Of these, age or period of development, sex, race, climate, and habits of life, are the most influential. The alimentary desires of development are manifested in every kind of organism. The plan of the developmental processes commences with a direct supply of suitable food to the ovum; an object attained by the most varied methods in plants and animals. (655, *sqq.*) In vertebrates, and especially mammals, the alimentary desires of the female parent are modified to suit the food required for the growth of the ovum or embryo. Thus, egg-laying hens pick up lime to supply that material to the egg-shell; pregnant women desire chalk, and the like. The larva or caterpillar stage of various insects requires an aliment wholly different from that of the imago or adult stage, while the appetite ceases wholly in the pupa-stage. In mammals, the successive stages of development require different kinds of aliment, and the appetite varies accordingly, milk being the food of earliest life. The maternal alimentative appetites are manifested at or after the period of puberty, at the time when the genetic glands are developed. When this period terminates in woman (about the age of forty-five), her appetites are assimilated to those of man. Natural history supplies abundant facts as to the sexual alimentary appetites in lower animals.

772. *Climatic Alimentary Appetites* are often those of

race, as well as of climate. Differences of climatic temperature determine differences in the aliments, with special reference to their heat-producing properties. Flesh, and animal oils and fats, are desired in the antarctic regions; in the tropical, vegetable aliment and vegetable oil are preferred.

773. *Habitual Alimentary Appetites.*—Organisms are not only adapted to circumstances according to a plan, but that plan also includes an adaptability to new circumstances. Hence acclimatization, which is an adaptation of the entire vital processes to new climatic circumstances; hence the capability and desire, under the pressure of hunger, to take things as aliments, not otherwise desirable, is by long continuance developed into a habit, and so becomes a second nature. In this way, food of even a disgusting character at first, finally becomes pleasurable, and is desired.

774. *Irregular or Parœsthetic Alimentary Appetites.*—Various chemical materials enter specially into the composition of the blood and tissues. When these are specially defective as to supply, an appetite for them arises. In this way there is a natural therapeutics developed. Lime, common salt (chloride of sodium), sugar, and sweet things, fats, vegetable acids, and the like, are things especially desired from time to time, in particular conditions of the blood and tissues. These desires are not unfrequent in the pregnant woman, when they are termed Longings. They often arise, also, in the course or at the termination of diseases. Thus, patients recovering from cholera desire savoury things. This seems to be really a desire for common salt, induced by the want of it in the blood; for the fluids discharged from the intestinal canal so profusely in cholera contain a considerable amount of chlorides. Such seems also to be

the explanation of a similar desire at the end of a long illness, during which tea and "slops"—*i.e.*, things containing few if any chlorides or potass-salts—have constituted the principal diet of the patient. Sometimes children, the offspring of gouty parents, reject milk and sweets altogether, and have the appetite for flesh-meat developed in a remarkable degree. This not unfrequently is nervous in its origin, but in other cases it is evidently remedial. Dirt-eating, and the various forms of morbid appetite termed *Pica*, belong to this group. The right interpretation of these peculiar food-appetites is of great practical importance in the treatment of disease.

775. To this group of alimentary desires belong also what may be termed the *medicinal* class. In these there is an appetite for medicinal agents—that is to say, for things which, in the ordinary course of health, are articles of aversion and contra-natural, but which are taken in sickness with at least preference, if not pleasure. Cats and dogs are known to eat a particular kind of grass medicinally. To this group also belong an intermediate class of desires—viz., those which have drugs for their object, which induce the pleasant feelings of *Life*, or relieve the painful feelings associated with bodily consciousness. Opium-eating, drunkenness, intoxication by bhang, betel-nut, hachish, &c., are illustrations of this group of appetites.

776. *The Appetite for Muscular Activity.*—The organism is constructed, as to its organs of consciousness and voluntary motion, to be alternately in a state of activity and repose. When the need for activity arises, the desire for it is felt. It is most markedly manifested in the young animal, and is very striking in young mammals. In the young, muscular activity is necessary to muscular development, and to the training of the muscles.

Hence we observe that future instinctive acts are mimicked, especially acts of self-defence and attack. The young animal is thus instinctively trained to its future duties.

777. It seems probable, that there is a certain amount of motor force developed in each individual, and that this must be expended, otherwise the animal is unsatisfied (419, 477). It is from this cause, apparently, that young children and young animals in general, when in health, are in such perpetual movement; the desire for activity seems often to be wholly irresistible. To the same cause we may attribute the restless activity of caged and imprisoned animals, especially as seen in menageries. The perpetual activity seen in certain forms of insanity appears also to be due to a morbid development of motor force.

778. *Appetite for Open-Air Life.*—This is one of the most universal of instincts, although not recognised formally by physiologists or psychologists. It is fundamentally a desire for a state of nature, and of life with nature, as compared with the restraints of a civilised civic life. It is not peculiar to man, but is shared by the domestic animals he has about him—the horse, dog, ox, sheep. It is a desire probably complex in its origin; for the gratification of it aims at the attainment of several ends necessary to organic well-being, such as muscular activity, light, pure air, and stimulation of the nervous system by the sights, scents, and sounds of nature. It is particularly felt by the town-bred man, or the man who, bred in the country, has gone at an early age to reside in a large city. It is shown in a great variety of modes, as by the love of flowers, by delight in poetry which describes natural scenery, or by the love of landscape painting. It is probably not unfrequently due to the re-excitement of ancestral substrata (427), for it sometimes is manifested in

the children of townspeople with considerable intensity. Some such state is also developed even in well-bred persons who, seized with the mania of vagabondage, abandon all the comforts of town and civilised life to wander freely in the woods or over the prairie.

779. *Habitual Desires for Muscular Activity*, of a special character, are numerous; many of them unmeaning, many associated with favourite pursuits, as uses of instruments and the like, and requiring special groups of muscles to be called into action. The whole class of habitual grimaces, drummings, twitchings, &c., belong to this group. When the desire is morbid, and arises from morbid states of the nervous system, it is *fidgets*. When the motions are produced unconsciously or involuntarily, as a consequence of disease, they are chorea, St Vitus' dance, &c.

780. A great variety of morbid phenomena, belonging to both this group and the preceding, are developed in the fatuous and imbecile, and in certain forms of chronic mania. Morbid alimentary appetites of every kind, as the eating of green grass or any raw vegetable, of raw flesh and putrid flesh, of fæces, chalk, earth, are seen; loathings, longings, and caprices of every kind are manifested. Endurance of heat or of cold, of thirst or of hunger, is often a striking characteristic. Strange loss of desire for muscular activity is observed in others, so that the patient will remain dumb, or be fixed in the same position for many days or even years. Or there may be a development of special instinctive acts and modes of activity. Thus, some patients, whenever possible, gnaw or bite, pick or tear things in pieces; others pick or dig holes, or daub the walls, arrango things in rows, walk incessantly the same short path, turn incessantly on the axis of the body, first in one direction, then the other,

alternately; make all possible gesticulations; imitate automatically the movements of others; imitate the sounds of animals—barking, crowing, miauling; talk incessantly and incoherently; or appear as orators, declaimers, monologists, dialogists. In all these cases, the muscular actions are done without any special desire or idea, the intellect being either wholly gone or life only a poor dream, deprived of all change of consciousness, and with nothing in the mind, therefore, beyond the one simple desire for the automatic act,—except, possibly, the simplest organic feelings, and even these are sometimes deficient.

781. The instinct for busy activity is sometimes developed in children, particularly in boys, as the love of mischief. This is most commonly seen in those who have been kept under restraint. Mr George Wilson, of the Belmont Factory, informs me, that the many boys they employ are perfectly docile and steady while they are kept at their usual duty of attending to the candle-frames, which move with the regularity of clockwork. If, however, the engine that moves the frames stops by accident, and the boys have nothing to do, they become almost unmanageable, so full are they of play and mischief. Mr Combe mentions the case of an exceedingly mischievous boy who was sent to Dr Howe of Boston, U.S., as a pupil. He was so full of destructive energy that he broke the benches, tore the chairs asunder, swung on the doors until he wrenched them off their hinges—perpetrated, in fact, every possible mischief on frangible objects. All moral counsels were useless. At last he was sent into the cellar for three hours every morning to saw and split wood. This exercise had the effect of curing him.* In some forms of mania, this desire for

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* *Visit to the United States*, vol. i. p. 257.

muscular activity is so extraordinarily developed, that if its gratification be prevented by mechanical restraint or confinement, the maniacal excitement increases to a terrible blind fury. In the morbid appetites of the insane, there is sometimes a meaning which the skilful and experienced physician will detect (695).*

782. *Appetite for Variety.* — The preceding remarks have reference to the absolute class of appetites connected with dynamisation and alimentation, and their derivatives; but there is another kind, which is contingent and antagonistic. A variety of stimuli seems essential to the proper performance of the corporeal processes; when the same stimuli are constantly applied, vital changes are not sufficiently excited, for all life consists in change. Hence, persons who are obliged to adopt great sameness of diet become disgusted with their food.

783. Variety in food is necessary to the supply of the various constituents of the blood and tissues, upon which all change depends; so that however nutritious an article

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* A case of a young man under my care was characterised by exalted desire for bodily activity, and an irresistible propensity to tear grass or any green thing from the ground, and eat it. For some time the symptom was not rightly interpreted, but at last it became obvious that it was a medicinal corporeal desire for a diet of fresh vegetables. The patient was therefore allowed an almost unlimited supply of raw culinary vegetables, as carrots, turnips. beet-root, cabbages, lettuce, celery, &c., which he devoured greedily in large quantities; and very soon recovered, after a prolonged attack of furious mania, during which he tore up many suits of clothes, broke hundreds of squares of glass, often assaulted his attendants and the other patients, and was altogether the most mischievous, destructive, and uncontrollable patient ever treated. This and other illustrations of these doctrines are given in my essay "On some of the Latent Causes of Insanity," *Psychol. Jour.*, vol. vii. p. 168.

of food may be in itself, if taken alone or continuously it is loathed, and variety desired. This is true of animal food of the best kind—beef, mutton, game, salmon—as well as of butter, bread, milk. Usually, the more simple the article of diet, the more it is loathed. This dietetic sameness is particularly felt to excite the appetite for variety during sieges, in ships on long voyages, in institutions too regularly conducted as to the diet-table (prisons, workhouses, public schools); the health of the persons thus subjected to it suffer, even although the food be good of its kind.

784. Variety of stimuli is also necessary for healthy mental life as well as corporeal strength. Solitary confinement tends to induce imbecility and insanity; too great sameness of pursuits tends to eccentricity in individuals, or, amongst bodies of men, to insubordination. It is perhaps partly to this sameness of pursuit that the tendencies to encephalic disorders are due, observed amongst the sparse inhabitants of mountainous regions or remote valleys.

785. In married life, this desire for variety is sometimes the cause of adultery, or at least of dangerous "flirtations." It is also an exciting cause of profligacy and irregularity of conduct, and of running away from home in the children of families too strictly disciplined as to moral and religious duties; or of families in which an ascetic temper rules, regardless of the strong desires for activity and variety which are felt by the young and vigorous. In this way the unphilosophical disciplinarian defeats his own object, and ruins a fine character. He either breaks down the healthy impulse for struggle and action, or excites it into vicious rebellion. And even the same principles are operative in national polity. A repressive system of government operates upon the mass

as upon the individual: while a well-ordered *laissez-faire* secures solid order amidst a few disorders, a meddlesome interference prevents trifling disorders, but sooner or later involves the solid order of the whole in disaster.

786. *Sensual Appetites.*—The frequent gratification of an appetite may so strengthen it that it may overmaster the judgment; or the love of pleasure may lead to its continued gratification after the teleiotic end of the appetite has been attained; such gratification is unnatural and sensual, and is that which has been ethically termed *Lust.* Thus, if the desire to eat continues after the stomach is repleted, its gratification is *gluttony:* if the desire for drink after the body is refreshed, its gratification is *drunkenness;* if for sexual congress after the legitimate and normal performance of the function, its gratification is *sensuality.* Nature, that is, Divine Providence, has placed barriers to this vicious exercise of the appetites in the feeling of satiety, and then of loathing, which often follows the feeling of satiety. Sensual men endeavour, however, to escape from these checks by various modes of procedure. The glutton will excite the act of vomiting, that he may be able to eat again; or will fast, that he may be able to eat the more; or will have great variety in his dishes, so as to avoid the sameness which leads to satiety. In like manner, the sensual man will seek to stimulate his sexual appetites by unnatural stimuli, or gratify it by variety as to object and mode. These are of the class of sensual vices; they are all more or less destructive to health of both body and mind, and hence are the vices which, when generally prevalent, destroy national power (vol. i. p. 30).

CHAPTER XI.

PHYSIOLOGY OF THE CORPOREAL LOATHINGS AND AVERSIONS.

787. We have seen that there are two fundamental forms of desire, one of which is the desire to acquire, the other the desire to avoid (359). The latter is presented in two forms—first as a desire to avoid what is absolutely injurious; and second, what is relatively injurious, as excess of light, heat, food, and vital action generally. I propose to consider a few of the leading forms of both these classes of the *desire to avoid.*

These desires are variously designated, according to the things which are the object of the desires, or according to the portions of the organism which they affect: *i.e.*, whether it be the seat of the corporeal feelings, or of the higher sentiments: Aversions, Loathings, Disgust, Antipathy, are amongst the most common terms used. The entire class of feelings includes a painful element; they are therefore to be classed with the painful feelings, however they may arise.

788. Limiting our inquiries to the class of corporeal origin, it can be stated generally, that all conditions averse to the due maintenance of animal heat are abhorred or disliked; cold air, cold moisture, or dampness, are the principal things which excite this painful feeling on the one hand, and the want of clothing and artificial heat on the other.

789. It is necessary to the well-being of the individual

that the atmosphere be pure. Things which, if inhaled with it, will injuriously affect the vital processes, are therefore objects of loathing or aversion; and accordingly they affect either the olfactory nerves, or the branches of the 5th. These nerves spread over the mucous membrane of the nose, and thus constitute a sentinel-apparatus, like the nerves of feeling. It is not, however, every injurious constituent of the atmosphere that affects the olfactory nerves. Carbonic-acid gas has no effect on them, although it stimulates the sentinel-apparatus (vagus nerves) of the glottis to contract and thus wholly to exclude the atmosphere from the lungs, causing no feeling except that of suffocation. On the contrary, sulphuretted hydrogen gas both affects the nerves of smell and the nerves of the glottis, causing the feeling of loathing and the feeling of suffocation. This seems to be the rule with all the combinations of hydrogen with bodies analogous to sulphur.

790. The respiratory loathing for offensive things, the odour of which taints the atmosphere, as fœces, putrid things, &c., is prophylactic. Hence, although it by no means follows that every inodorous gas or vapour is harmless, it may be adopted as a safe general rule, that those which are offensive are injurious. But it must be also remembered, that in virtue of the adaptation of the organism to external circumstances, which is part of the general scheme of life, offensive things are rendered innocuous; and then, the things ceasing to be offensive, the sense of smell and the sentinel-nerves of the bronchi are no longer affected—that is to say, do not affect the sense of smell. This change in the organism is termed *habituation*. Men who have to deal with putrid animal matters or with fœcal accumulations, as night-men, scavengers, workers in knackeries, tanneries, sewers, and the like, encounter the poisonous gases to which they are habitu-

ated with impunity, except when respired in suffocative doses. The habituation of the whole system to malarious gases, or the emanations of decaying vegetable or animal and vegetable remains in marshes, or from decomposing volcanic soils, is *acclimatization*, and is shown as an ethnic character in the dark races (751).

791. The counteraction of chemical gases or of minute particles of matter diffused through the air, which exercise a mechanical irritation upon the respiratory tissues, is provided for by the same means as are directed against mechanical or chemical irritants in general. Sneezing, coughing, and spasmodic closure of the glottis or bronchi, are the acts these induce; and they are therefore not necessarily objects of loathing. Nay, they may affect the olfactory nerves in the same way as comparatively harmless odours. Thus, the fatal arsenical gases have the harmless odour of garlic.

792. *Disgust.* — Alimentary loathings are directed against a great variety of objects; in these, both the senses of smell and taste are affected. Strictly, a loathing directed against anything to be taken into the mouth is *disgust;* nevertheless, the term is generally used in reference to both offensive odours and tastes, whether they are from articles of food and drink, or not. The nerves of the palate and the nostrils constitute, with the tissues upon which they are distributed, the sentinel-apparatus of the alimentary appetite. As a general rule, therefore, whatever is offensive to the taste and smell, and is loathed, is likely to hinder the proper performance of all those vital processes to which aliment is subservient. Hence the excreta of men and animals, putrefying flesh, decaying vegetables, &c., are disgusting.

793. The sense of vision is also part of the sentinel-apparatus of the alimentary function. Filthy water or ugly

living creatures, especially crawling things, are disgusting articles of diet to mankind in general, and are loathed. And this is true of various visible qualities of aliment, both solid and fluid, and in lower animals as well as man; some of these discriminate with great nicety, by the eye, what is gusting or disgusting. These, however, are facts of natural history.

794. Poisonous vegetable substances used for medicinal purposes, and known as drugs, are usually loathed; a nauseous bitterness is their most common characteristic. *Chemical* drugs may, however, although highly poisonous in large doses, have little or no taste, or may be even pleasant. Thus, arsenic is almost tasteless; calomel (or *Mercurius dulcis*), a salt of mercury, is so called from its comparatively sweet taste. The same rule applies, therefore, to the nerves of the alimentary appetite as of the respiratory. Further, irritation of the pharynx and gastric or gastro-intestinal mucous surface, by chemical or mechanical irritants, leads to attempts at expulsion, either by vomiting or purgation, or both, with much corporeal pain. Hence the characteristic symptoms of the whole class of acrid poisons.

795. Upon a review of the substances which are loathed by the alimentary appetite, we may, I think, draw this general conclusion, that the things loathed are those of which no knowledge as to their injurious effects can readily be attained, and which do not necessarily cause mechanical injury to the tissues. Acrid things are rejected by the sentinel-apparatus of feeling and conservation; animal and vegetable substances, not acrid, yet injurious if taken, are loathed. In reference to the usual division of the nerves into those of special sense and cerebral, and those purely organic, it may be here noted, that these three cerebral nerves of vision, smell,

and taste, are in truth as much organic in their relation to these corporeal states of the appetites as the simplest nerves of feeling. What distinguishes them is, that the terminations are so connected with a special apparatus—an organ of sense—that external things not acting on the simple nerves of feeling, as they are distributed through the textures and on the skin, may be thus brought into fitting relation with the organism. The state of the consciousness, therefore, in loathing and disgust, is not essentially different from that of pain; its special characteristic is, that it refers to special objects, and has reference to special properties in those objects that are injurious. When the man designates those things as acrid, bitter, sweet, stinking, and the like, the state of consciousness is wholly different from this of loathing; it is more mental.

796. *Idiosyncrasies.*—Some individuals are so specially constituted, that things are loathsome and disgusting to them, injurious to their health, and painful in their operation, which are not so to mankind in general. This peculiar constitution is termed *Idiosyncrasy*—a Greek word, simply meaning a peculiar constitution. The condition is clearly referable to a locally morbid condition of the nervous system—is a congenital hyperæsthesia or painful sensibility, limited to certain classes of impressions.

797. *Abhorrence of Restraint* is occasionally manifested in a marked degree as an idiosyncrasy. In these cases all the restraints of civilised life as to muscular activity in the open air, and as to those circumstances which interfere with the appetite for natural life, are an antipathy. This condition is very often at the basis of a certain kind of wandering mania, in which a person, otherwise respectable, resolutely, from some blind impulse, throws off these restraints and takes to a vagabond life. This aversion

has a close relation with the desire for vital activity, and has had consideration already in relation to that appetite.

798. *Aversion to Activity*, or *Desire for Repose.*—During a period of vital activity, the materials in the blood and tissues which subserve to the vital forces are used up. Activity is then no longer pleasurable; painful feelings, known as Fatigue, arise, and therewith a desire for repose or rest of the organs of consciousness and will. This state of rest is sleep, during which a renewal of the materials and forces necessary to activity is effected. Alimentation usually follows active efforts; then after food comes rest. Digestion and chylification go on during sleep with all the concomitant processes of nutrition; these restore to the blood and tissues the materials necessary to effort; the rest then terminates, and the desire for activity again comes into play.

799. The opinions entertained as to the cause of sleep have been various, although all persons agree that it is "tired nature's sweet restorer," or the period when the vital powers are recruited. My friend, Dr Lyon Playfair, is of opinion that it is due to the want of oxygen in the blood, an opinion which has many facts in its favour.* When venous blood circulates through the brain, or when anything is introduced into the blood which takes up oxygen (such as alcohol), sleep comes on. Animals tend to sleep in inverse proportion to the amount of oxygen consumed by them, and the amount of carbonic acid produced; thus, reptiles and the naked Amphibia produce one-tenth of the amount evolved by mammals, and one-nineteenth of that evolved by birds. Dr Playfair in like manner attempts to explain the tendency to sleep after a heavy and excessive dinner: the distended stomach prevents

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* *Northern Journal of Med.*, No. I., 1844; and *Phrenol. Journal*, vol. xvii. p. 327.

the free play of the heart and lungs, and thus deprives the blood of its proper amount of oxygen. Fat people, he thinks, are peculiarly prone to sleep, because the fat accumulates around the viscera, and, pushing up the diaphragm, acts in the same way on the heart and lungs. In this way, Dr Playfair thinks the sleep of hybernating animals (which are very fat) can also be explained. In dreaming sleep, there is oxidation going on in the part of the brain subservient to dreaming, but not in the other parts that are asleep. These are the chemist's views, and true in part.

800. There are several series of events to be considered in the various states termed Sleep. First, the using-up of the nutrient materials of the nerve-tissue by oxidation is one series. This is seen in its typical form in the sleep which follows upon exposure to cold and fatigue conjointly; for both combine in the production of this kind of sleep. There has been an oxidation of nutrient stuff, both for the purpose of producing force for motion and force for heat, so as to maintain the proper temperature of the body, but especially of the lungs, exposed to the constant access of air at a low temperature. Now this last process is one which requires a constant change in the tissues, analogous to that which takes place in muscular activity. Hence the parenchyma and mucous membrane of the lungs may, during long breathing in a cold atmosphere, become unfit for the maintenance of heat, just as prolonged use of the muscular fibre renders it unfit for the continuance of motion. In this case the blood would cease to be oxygenated, from failure in pulmonary function. It follows, therefore, that the sleep from cold is not like ordinary sleep, but rather like death, or cessation of blood-aëration from failure of lung-function.

801. Again: the activity of the capillaries may be greatly modified in certain portions of the encephalon, the result of which will be to interrupt the access of affinitive impressions. Light, it is well known, or sound, or touches, or anything that excites the attention—or, in other words, the teleorganic changes coincident with consciousness—will keep a person conscious, or, more correctly, cause wakefulness. Hence the need of silence and darkness for sleep under ordinary circumstances. Now, the arrest of the access of affinitive impressions may depend upon changes in the *medulla oblongata*, such that the changes in the sensory nerves caused by them are not propagated to the organs of thought and will, and so they cease to be active. The paralytic dropping of the eyelid, the cessation of tension of the tympanum, and, finally, the loss of reflex co-ordinating power in the muscles of the trunk and limbs which usher in deep sleep, point to this order of events as antecedent to or a cause of it.

802. The condition of the blood in the capillaries has doubtless an important influence upon their functional activity in this respect. Chloroform induces this incapability of transmitting afferent or affinitive impressions, and so renders injuries painless without wholly abolishing consciousness; but if used too freely, its effect extends to the heart and lungs, and death ensues; and this is also the case with other drugs. It is probably also the state in cataleptic, mesmeric, and other like conditions of the nervous system. Cachectic delicate people, with enfeebled blood-powers, growing children, and chlorotic girls, all require and take much sleep.

803. Lastly, it is probable that the want of sleep tends to important changes in the encephalic tissue itself, but perhaps still more certainly to changes in the capillaries

and the blood-vessels. Continuous functional activity of these would lead, as it leads in the use of the ordinary locomotive apparatus, to changes in their nutrient powers. Hence loss of elasticity, dilatation (varicose and otherwise), and then atheroma, or fatty degeneration of the vessels of the brain. With these changes gradually advancing, there would be gradually advancing changes in the mental manifestations, such as characterise the insanity which ends in general paralysis. To this point in the pathology of that disease I will, however, revert more especially.

804. The desire for repose, or the aversion to activity, is therefore a very important primordial instinct, and is often highly prophylactic against a too great exhaustion of the vital powers. If this feeling be overcome by artificial stimuli, as opium, alcohol, and the like, and the individual urges on his powers, whether of mind or body, the risk of serious disease arises. Hence prolonged mental or bodily labour under stimuli of this kind is dangerous to health of both body and mind.

805. *Languor* is a condition of the nervous system which is associated with all morbid states of the blood and nervous system in which there is an interruption to the production and transference of force. Hence it is an affection of the cœnæsthesis, manifested in fevers and other acute diseases (729), and is associated with an intense aversion to muscular effort and with muscular aches. It is in fact one of the earliest and most common symptoms of disease, and is rarely absent unless the sentinel-action of the nervous system itself be destroyed in the course of the disorder. *Drowsiness* is a condition intermediate between sleep and languor, and, when it occurs naturally, is due to the same cause. It is also an early symptom in many acute diseases of the blood in which the nerve-centres are implicated.

806. *Loathing from Satiety.*—The injurious results which follow from excessive stimulation of the vital forces, when the resulting state of consciousness is pleasure, is provided for by the access of a feeling termed Satiety. This is more than the feeling of being satisfied, which is the absolutely pleasurable result aimed at; whereas satiety includes, in some degree, the not-pleasurable feeling of more-than-enough. This feeling is induced also by sameness of stimuli. Hence it is not only the natural guard against excess, but also against that monotony of vital activities, whether in food, drink, or mental action, which is obstructive to healthy life (782).

807. *Abhorrence of sexual union*, or sexual loathing, arises under various circumstances. It may supervene upon a modification or cessation of functional activity in the generative glands. This is seen in some of the lower animals, of which the female repels the male so soon as impregnated. In man, it is very commonly the result of satiety, and is therefore most apt to occur in those cases in which a violent physical passion has led to union of the sexes, and to excessive gratification of the sexual appetite. In these instances the woman usually retains her relative feelings, and it is the man who becomes indifferent, and finally averse, to further intercourse. The feeling, as a mere corporeal condition of the consciousness, is perhaps hardly ever wholly absent after newly-married persons have lived together for a while; but moral feelings or intellectual affinities interfere with its development as a cause of conjugal unhappiness, or it is suppressed by well-regulated minds. Although its bad results are by no means uncommon amongst educated people, they are mainly manifested in the harsh treatment and desertion of young wives, so common

amongst the wholly uneducated classes. In the higher ranks, it more usually gives rise to that condition vaguely termed Incompatibility of Temper. During the earlier years of married life this state of the appetite less frequently shows itself, as the mere physical desire for sexual congress is active, and keeps the tendency to separation in check. It is only when the sexual appetite becomes less active as age advances, and the generative glands fail, that the feeling of aversion has full play. Hence it happens that persons who have apparently lived happily together in the marriage state for several years, and have a family, finally separate in middle age from incompatibility of temper.

808. *Loathing of Life—Ennui.*—Satiety generally, as to the pleasures of life, is felt by those who have no better or more definite pursuit than self-gratification. The constant general stimulation of the appetites and desires induces a general exhaustion of the nervous system, and therewith an incapacity for further enjoyment, which is termed Ennui, or, in slang phrase, being "Used up." A man, like Sir Charles Coldstream in the play of that name, may look at St Peter's, or take a peep into the crater of Vesuvius, under such circumstances, and find nothing pleasurably exciting in either—"nothing in it."

809. These various corporeal loathings may be induced suddenly, and once for all, by any things which have made a powerfully painful impression on the organs of the appetites, so as to excite nausea, vomiting, prostration, or even a feeling of deep disgust, as between the sexes when something personally loathsome is developed in either. Such impressions may be used to check the propensities and alter the motives, and are in fact commonly so used in the training of both men and animals.

810. Loathings and aversions of all kinds may arise

from no external conditions, but may be due to morbid states of the nervous system. In this way antipathies to individuals arise, or idiosyncrasies as to particular articles of food, or even as to the appearance of things. Thus, the sight of beet-root has been known to excite the feeling of loathing. Sometimes the paræsthetic sensations are felt in these cases as a *bitter* taste in the mouth, a stench in the nostrils, &c.

811. *Loathing of Life*, or suicidal melancholia, is one of the most important of this class of centric diseases of the nervous system. It is to be distinguished from the suicidal impulse, in which there is a mere automatic, if not unconscious, development of the impulse to suicide (and which occurs in lower animals), inasmuch as it is associated with an intense phrenalgia or mental pain. Cases of suicide from intense bodily pain, such as that caused by an aneurism, have however occurred.* There are various special forms, in which the states of mind have reference to some predominant cause of mental pain. All agree, however, in the one point of resemblance, that continued existence is no longer desired—is no longer a matter of indifference, but of abhorrence and loathing, so that a desire arises to terminate it.

812. This life-loathing is the most hereditary of all the forms of melancholia. It is observed in children; and occurs even as a highly morbid development of the love of life itself—that is to say, in persons remarkable for their egotism, and fear of death or personal injury. In these cases, it is a hyperæsthesia changed into a paræsthesia (729).

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* Professor Walshe. *On Diseases of the Heart and Lungs*, 2d edit., p. 768.

CHAPTER XII.

ON THE RELATIONS OF THE VITAL POWERS TO MENTAL CHARACTER AND MANIFESTATIONS.

SECT. I.—*On the Temperaments.*

813. MEN differ from each other as individuals; groups of individuals differ from each other as nations; and groups of nationalities differ as races. And the differences thus noted are seen to extend to both the corporeal forms and the mental qualities of man. It remains now to inquire into the causes of these differences, in so far as they depend upon fundamental differences in the modes and laws of action of the vital energies, and of the mental powers, sentiments, and feelings.

814. For a long period, almost from time immemorial, a doctrine of Temperaments founded on Physiognomy (570) has been taught. Such a doctrine is the necessary development of the Faculty of diagnosis, which examines the causes of these differences of character in men and women, in so far as the corporeal powers are in relation to the mental. The term itself is of theoretical origin, and refers to a supposed mixture of certain hypothetical primary elements of the body. Hippocrates terms these blood, phlegm or pituita, yellow bile, and black bile. Each was believed to be the foundation of a correlative temperament or constitution—namely, the sanguine, the phlegmatic (or lymphatic), the choleric, and the atra-

bilious (or melancholic). Each also was, as it were, of a different hygrometric or thermometric character or quality, and was therefore distinguished as Hot, Moist, Cold, or Dry. Heat and moisture, it was said, produced blood; coldness and moisture, phlegm; heat and dryness, yellow bile; and coldness and dryness, black bile. These ideas seem to point to a climatic theory of causation, deduced from ethnic characters. Each temperament corresponds to a peculiar corporeal development, indicated by various external characters, as the form of the limbs, the size, the complexion, the production of hair, fat, and the like. Each, also, has its proper mental qualities, and each its peculiar tendencies to diseases, or disorders of body and mind. The best temperament, or crasis (*Eukrasia*), was considered to be that in which all are so equally mixed that no one predominates over the other.* The later Greek writers connected with the doctrine a cranioscopical phrenology, such as Albertus Magnus adopted (569), but which appears to have been unknown to Galen and his immediate followers.† These, however, included a cerebral physiology in their doctrines of the temperaments.‡ Various theories of temperaments have been promulgated at successive stages of medical progress, but all have been purely empirical. I am not aware, at least, of any doctrine of the temperaments, either ancient or modern, which has a scientific basis in the laws of life and organisation, nor do I think such a doctrine has been possible until lately.

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* For a full account of the ancient doctrines as to the Temperaments, see Paulus Ægineta, lib. i. § 60, *sqq.*,—vol. i. p. 84, of Dr Adams' able translation for the Sydenham Society.

† Dr Adams, in *op. cit.*, p. 90.

‡ Paulus Ægineta, in *op. cit.*, § 63, "The Marks of the Temperament of the Brain."

815. *Ethnic Temperaments.*—Commencing with the most general, we have first to notice that the different races of mankind differ much in temperament—*i.e.*, in corporeal and correlative mental qualities. The African differs from the Hindoo; the Chinese from the European; the Persian from the Hindoo or Malay; the American Indians from all. It would require a treatise on Ethnology to develop these ethnic temperaments in their full extent. I shall only glance, therefore, at leading differences amongst the ethnic varieties of that great Indo-Germanic or Aryan race of mankind, to which Europeans belong.

816. If we look at typical examples of the two extremes of this great and widely spread primordial race, we find the characteristics of two well-defined fundamental temperaments. The north German, or "Anglo-Saxon," as he has been termed, has little or no pigment-deposit in his skin or cutaneous appendages. In the Hindoo, it causes him to be of every shade of black or brown. Hence, the one has been termed "fair," the other "dark." The Anglo-Saxon, again, with his fair hair, blue or grey irides, and light complexion, has also a more or less copious development of capillaries on his cheeks, within which a rich red blood circulates; the Asiatic has no such marked development; his cheeks are of an olive or olive-brown colour, almost homogeneous.

817. Then, if we look to the locomotive apparatus and osseous formation, we find that the typical "Anglo-Saxon," as compared with the typical Hindoo, is of larger development in all respects. His limbs are more muscular: his hands, and feet, and fingers, thicker and broader; his cranium and facial bones more expanded and denser; his skin thicker. Within his more capacious thorax and abdomen he seems to possess a larger expanse of aërating and

digesting surface, as compared with the Hindoo. His jaws, too, are broader and more massy, and his teeth larger and stronger. In short, the organs of the corporeal appetites (627; 1) are all more largely developed in the typical Anglo-Saxon than in the typical Hindoo.

818. The mental characteristics correspond with these corporeal qualities. The Anglo-Saxon has a more active manifestation of all the physical-force energies.—He is fond of all things which gratify his instinctive appetite for muscular activity (777, 778). Field sports of every kind, and all open-air exercises, are his delight. With these he desires a free supply of heat-and-force-generating, life-stimulating food and drink (772); so that the heat of the body may be maintained in an atmosphere on the average from 30° to 50° below its normal temperature, and that the force necessary to move actively his large muscular limbs be supplied. Hence, he is not only a large eater, but a large flesh-eater; and hence, too, he is given to the use of alcoholic or fermented drinks. These appetites seem particularly due to the influence of a low climatic temperature; for as we approach the North Pole the appetite for flesh increases, until we find the Esquimaux eating a large raw salmon at a meal, and it is necessary for the voyager from a more temperate clime to double or triple his daily allowance of animal food. Little of all this is seen in the typical Hindoo.

819. The relative sentiments and faculties follow the evolution of the lower feelings. The "Anglo-Saxon" is more warlike and enterprising, more resolute and enduring than the Hindoo, but he is less subtle, less ferocious and impulsive. Conscious of his innate vigour, he is self-reliant and egotistic to a fault; but while he is thus led to affect a superiority over other races, he is also more desirous of individual freedom, and less given to social

unity and autocracy (526). The two races seem equally religious, but the Hindoo is more imaginative and æsthetic, perhaps more abstract and profound, though less practical than the Anglo-Saxon.

820. Now, it would be easy to develop the characteristics of these two typical temperaments, even in the great Aryan or Indo-Germanic group of races, in relation to climatic influences, and show how mountainous districts and alluvial soils, arid plains and moist damp regions, land, and water, and wood, and all the variations in the seasons which make up a climate, modify them so as to develop numerous subordinate temperaments. This is, however, far from our plan. At present we only note, that in these two typical temperaments we have the two fundamental forms of temperament in Europe—viz., the so-called *sanguine*, and the *fibrous* or *bilious* temperaments; of which the one predisposes especially to diseases of the locomotive apparatus and the nutrient processes more especially, the other to diseases of the nervous system.

821. There are, however, modifications of these temperaments of a general and fundamental character, which depend upon differences in the mode in which fundamental tissues are evolved, and the vital energies proper to them manifested, and which require notice here. The germinal layer of the embryo is composed of two fundamental or primordial tissues—the so-called mucous and serous layers—out of which the nutrient and locomotive apparatuses are respectively developed (558). Now, between and from these, the blood and the vascular layer of the embryo are formed; and finally the cerebro-spinal centres, destined to co-ordinate all, make their appearance. There are corresponding temperaments developed—

1. The *Arthritic.*—The *locomotive* structure evolved from the serous layer being predominant, there is that

form of the sanguine temperament produced which predisposes to gout and gouty affections of the joints, ligaments, muscular aponeuroses, and fibrous tissues in general. This is the sanguine form of the arthritic diathesis.

2. *The Vascular Arthritic.*—The vascular layer, corresponding to blood and blood-vessels (as motor tubes), including the aërating organs, the lungs, being predominantly evolved, that form of the sanguine temperament is developed which predisposes especially to diseases of the blood-corpuscles, the capillaries, and the heart and arterial system in general. This I name the *vascular arthritic*, inasmuch as it is often associated with the arthritic proper, particularly as to the tendency to diseases of the fibrous tissues, such as the connective tissues (especially of the derma and kidneys), the pericardium, Glisson's capsule, and the trabeculæ of the spleen.

3. *The Rheumatic.*—When the last-mentioned tissues, in particular, are the most predisposed to morbid action, and concurrently therewith there is a degradation of the blood-corpuscles, a modification of the arthritic diathesis is observed, termed the *Rheumatic.*

4. *The Lymphatic and Strumous.*—If the abdominal viscera be predominantly evolved, and there be a less vigorous evolution of the blood-corpuscles and vascular system than in the bilious or fibrous temperament, then there is that low condition of the vital energies—*i.e.*, low as compared with the Sanguine—which is known as the Lymphatic or Phlegmatic Temperament, and which is characterised by feebler blood and a predisposition to diseases and diatheses of imperfect nutrition and development, the chief of which is *Struma.*

5. *The Nervous.*—When the sympathetic and cerebrospinal centres are evolved predominantly, as compared with the other fundamental tissues, and more especially

those of the encephalon, and its vital energies be powerfully excited, the nervous temperament is the constitutional condition. This predisposes to all diseases and disorders of the brain and nervous system.

822. These five fundamental modes of vital energy may be greatly modified by age, sex, and mixture or combination with each other; by food, employment, and climate; and by the various conditions which modify either the vital energies in general, or those of the blood, the capillaries, the blood-making structures and glands, and the different divisions of the nervous system, taken as a whole. Thus, a combination of the lymphatic and arthritic constitutes a feeble diathesis, in which there is a tendency to the deposit of fat generally; a mixture of the strumous and vascular arthritic predisposes to atheroma and fatty degeneration of the vascular system, and an imperfect development of the blood-corpuscles.*

SECT. II.—*The Differences in the Constitutions of the Sexes.*

823. *The Constitution of Woman.*—I have already hinted at the differences which arise in the two sexes, in

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* This scientific doctrine of temperaments, founded on the laws of Embryology, and of the evolution, acquisition, and transmission of fundamental modes of vital energy, are explained in my course of Lectures on the Practice of Medicine, in which I set forth the etiology of the mental and external characters, the morbid tendencies, and the leading modifications by various conditions, of these temperaments and diathetic states. The practical applications of the doctrines to the treatment of disease are shown at the bedside, in my courses of Clinical instruction in the clinical wards of the Royal Infirmary at Edinburgh; in which I teach diathetic diagnosis and therapeutics, in addition to the ordinary modes of physical diagnosis. An outline classification of the diatheses is given in my published *Lectures on the Principles and Methods of Observation and Research.* A. & C. Black.

consequence of that law of physiological division of labour, in virtue of which two distinct organisms are required for the maintenance of the species (519, 520, 643, 644). Now, while it is certain that many of the peculiarities of woman depend wholly upon her social relations, and these, again, upon the functions of the generative glands, it is equally certain that the evolution of them is due to a primordial difference in the force of evolution in her as compared with man. According to Autenreith, Sömmering, Meckel, and Velpeau, there are certain distinctive peculiarities, in the size and general conformation of the sexes, observable in the early months of fœtal life—such as the particular structure of the thorax and abdomen, the form of the head, extremities, and dorsal spine*—before there is any perceptible difference in the genetic organs; these being similar in the two sexes up to the eighth week. This difference continues after birth, the female child weighing less than the male up to twelve years of age. At this age they are equal in weight, but at fifteen the female is a few ounces heavier, owing to the more early accession of puberty in her; at thirty, however, the male is again considerably the heavier, and maintains the superiority in size up to ninety.† The difference in vital force in man, as compared with woman, is shown in various ways. Thus, in cases of congenital malformation, such that the ureters open upon the surface of the abdomen, the number of male to female children affected is in the proportion of 51 to 8.‡ So also as to congenital deafness. Kramer mentions a family composed of five daughters and six sons; all the latter were born deaf, none of the former. Statistical inquiries in Austria show that four in five of the children born deaf are males.*

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* Dr Granville. *Graphic Illustrations of Abortion, &c.* (1836), p. 11.

† M. Quetelet. *A Treatise on Man, and the Development of his Faculties* (Messrs Chambers' translation, 1842), p. 63.

‡ Dr Duncan, jun., *Edin. Med. and Surg. Jour.*, vol. i.

824. Various hypotheses have been advanced to explain the corporeal differences between the sexes. Cabanis believed it might depend upon some peculiarity in the organisation of the nervous system. G. St Hilaire, Serres, and others, inclined to somewhat similar doctrine, since they thought the development of an organ in the embryo is in some ratio to the amount of nervous tissue contained in it. Meckel, G. St Hilaire, and Blainville, looked upon woman as an imperfectly developed male. In one sense this may be admitted, for she is of less size and muscular power; but she is perfect in being perfectly adapted to her position in creation. In her moral relations, she is perhaps superior to man. Nor does inferiority in size attach to the female as a general law; on the contrary, she is superior in various species of both vertebrates and invertebrates.† Without attempting at present the solution of this problem, we can state very accurately, that in two points there is a practical difference between the sexes—namely, in the vital forces of the blood and the blood-vessels on the one hand, and of the nervous system on the other.

825. *Differences in the Sexes as to the Blood and Blood-vessels.*—The difference between man and woman is strikingly shown in the less predisposition of the latter to all those diseases of the blood-vessels in which there is calcification and atheroma, or such changes in the capillaries

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* *Edin. Med. and Surg. Jour.*, vol. vii. p. 62.

† "Inferiority, not of size only, but in grade of organisation, is no uncommon characteristic of the male in the invertebrate series" (Professor Owen, *Lectures on the Invertebrata, &c.*, p. 51). The male of the Lernæa, and of certain Cirripeds, is merely a minute parasite attached to the body of the female.

that morbid blood is allowed to escape. Of the latter form of diathetic state, the hæmorrhagic diathesis is the most remarkable. It is characterised by a hereditary tendency in certain families to dangerous hæmorrhage from very slight wounds, as the extraction of a tooth, or a simple scarification, or from other and spontaneous causes. Now, this hereditary tendency, although transmitted by the female side, appears almost exclusively in males, or in the proportion of fourteen males to one female.*

826. Further, other diseases of the vascular system, both acute and chronic, are more common in men. Sir J. Forbes collected eighty-eight cases of *Angina pectoris*; of these, eighty were men.† Mr Hodgson found that in sixty-three cases of aneurism of the aorta, only seven were in women. Barth found narrowing of the aorta much more frequent in men. Out of a large number of cases of acute pericarditis, Louis found that three-fourths were in men. Bizot and Bouillaud have confirmed Louis' statements. The occurrence of hæmorrhagic apoplexy is often due to rupture of the cerebral arteries from atheroma or brittleness. Falret found, in a large number of cases, three men to one woman were attacked by it.

827. Now, the most obvious explanation of these facts is, that all these differences are due to the different social position of woman, and to the habits of man, especially as to the use of wine, excessive muscular activity, and the like. These are doubtless con-causes; but a little consideration serves to show that it is not a sufficient explanation. *Angina pectoris*, for example, is almost always associated with calcification of the coronary arteries; now women are just as likely to have

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* Dr L. Grandidier. *Die Hæmophilie oder die Bluterkrankheit.* 1855.

† *Cycl. of Prac. Med.*, Art. "Angina Pectoris."

the heart's action disturbed, in virtue of their emotional character, as men in virtue of their more active life. If, therefore, increased activity of the circulation through the muscular structure of the heart is the cause of the arterial degeneration in man, we might expect it to occur in woman also. The fact that wine and other drinks are taken more freely by men is important, and doubtless the habit predisposes to the production of those blood-poisons (the gouty) which act specifically on the motor tissues; but then men have calcification of the arteries who are remarkable for their temperance, while temperate women also, of a strongly-developed arthritic diathesis, are not exempt. Further: if habits of life are admitted to explain one class of fundamental differences in the vital powers of the sexes, they should be sufficient to explain all. But all the purely developmental processes are entirely out of this category.

828. *Differences in Sexes as to the Nervous System.*—The nervous system of woman differs in some respects fundamentally from that of man. Tiedemann found that the brain of woman weighs from four to eight ounces less than the brain of man. Sir William Hamilton determined the less average in Scotch women to be four ounces. One in seven of men's brains exceeds four pounds in weight, but only one in a hundred of women's brains. And the mental organology of woman, looking at her social duties, must differ also. She is not required to engage in abstract speculations which involve the intellectual powers; nor, as compared with man, has she these powers highly developed. On the other hand, her relative duties (520) require her to have the faculty of diagnosis perfectly developed (570); hence she is quick in perception, and, when her judgment is not affected by her feelings, appreciates the character and motives of

others more readily than man. It would seem, too, that the minor constructive acts, especially as to clothing and domestic utensils, are peculiarly within her sphere, and that in all works requiring manual dexterity, she can equal if not surpass man. Hence her capability for a number of sedentary employments, as type-setting, engraving on wood or on metals, bookbinding, and all similar employments, requiring delicate manipulation rather than strength.

829. It is, however, in the emotional development of her nervous system that we have the most striking differences. Woman, as compared with man, is of the nervous temperament. Her nervous system is therefore more easily acted upon by all impressions, and more liable to all diseases of excitement. Her sedentary habits, and the less perfect condition of her blood when resident in towns, greatly increases this natural sensibility or affectibility of her nervous system;* and when both are combined with the erethistic influence of the generative glands on the nerve-centres, the varied morbid states of the cœnæsthesis grouped under the term Hysteria result (741, *sqq*). Now men, no doubt, are sometimes hysterical; but it will be found that in these apparently exceptional instances, the general causes are really those of hysteria proper.

830. Men are more liable to that form of insanity which is associated with general paralysis. Its frequency in women is stated very variously by writers, but all recognise that it is comparatively rare in them. The nature and causes of this disease have been much discussed, and are still undetermined by the majority of those few physicians who have inquired into its patho-

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* For a discussion of this subject, and its pathological relations, see my *Treatise on the Nervous Diseases of Women*, p. 76.

logy. My own opinion is that it is most usually diathetic in its origin, and is primarily a disease of the cerebral blood-vessels. The statements of Mr Austin, our latest writer on the disease, are quite in conformity with this view. The arteries are rigid (he says) in at least 50 per cent. of general paralytics,* and after death the arteries of the white matter of the hemispheres are atheromatous, or at least imperfectly elastic.† In this respect, therefore, it is due, diathetically, to the same general causes as calcification of the coronary arteries, and aneurism and atheromatous affections of the great vessels. It occurs most frequently in men of the sanguine temperament, in the proportion of two-thirds of the cases, and *probably* of the vascular arthritic diathesis; but there are no sufficient observations of the diathetic causes. I have seen it in none other. It occurs, too, most commonly, at the age when gout and gouty diseases first occur—namely, middle age. Thus, in 143 cases mentioned by Mr Austin, 5 only were aged from 20 to 30; while 47 were aged from 30 to 40, and 52 from 40 to 50, or 99 in 143 of all ages. In short, it follows the law of diathetic diseases in men of the heart and arterial system, and of the locomotive apparatus in general. Hence my conclusion, that this very serious, if not terrible form of insanity, is essentially diathetic in its nature, and seated in the blood-vessels, has a solid foundation on general facts, independently of my own observations to the same effect. A middle-aged man, therefore, predisposed hereditarily or diathetically to diseases of the heart and blood-vessels, is more likely to suffer general paralysis, if exposed to the exciting causes, than one of the same age not so predisposed; and still more than a woman, in whom such predisposition is constitutionally at a minimum, and in whom it will only arise from a very strong tendency to gouty disease of the blood-vessels transmitted hereditarily. It is necessary, however, to name amongst the exciting causes, not only great mental and emotional excitement, want of sleep (803), and the like, but all causes which influence at the same time the proper composition of the blood, and so facilitate that morbid change in the vital powers of the capillaries and smaller vessels of the brain to which I refer the disease. An important cause of this kind is a strumous taint of the system.

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* *A Practical Account of General Paralysis* (1859). p. 49.

† *Ibid.* p. 180.

SECT. III.—*Individual Differences of Character—Differences in the Development of the Faculties.*

831. Setting aside differences between individuals arising from differences of race, temperament, and diathesis, it remains to inquire why individuals, alike in all these particulars, differ from each other in their vital forces and mental endowments.

For an explanation of these differences, we need not go beyond that general law in virtue of which all varieties as to species arise.* While in a civilised community the mere external conditions as to physical agencies are nearly the same for the majority, the social relations of each individual, owing to the operation of the social principle of division of labour, are very various. Hence arises, even from mere differences of professional pursuits, a special exercise of some of the faculties and a diminished exercise of others; and concurrently therewith, an evolution or recession of the material substratum; or, in other words, a diminution or development of the mental "organs." When this is repeated in one or two generations, a tendency to the hereditary transmission of the predominant active faculty arises, and thus peculiar family and personal characteristics are developed. This law is necessarily of general application to all modes of mental activity, whether of the intellect especially, or of the sentiments, propensities, and instincts, and to all modes of vital activity. (425, *sqq.*)

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* Part IV. chap. v. § 2.

832. The singular extent to which the faculties may be cultivated by exercise, is hardly appreciated. While metaphysicians speak of the accuracy and precision of the instincts of animals, especially in construction (as that of the bee), they forget that such modes of energy are shown much more marvellously in man (p. 99, foot-note). The "execution" of artists of all kinds, of a superior class, whether musicians, painters, mechanics, or "prestidigetateurs," amply illustrates this general law. To artistic success, two things are necessary : *first*, intuitional power, or the æsthetic faculty ; *secondly*, expressional or representative power, or the manual dexterity sufficient to represent the ideas in material. With such connate powers, the artistic genius is able to rival the finish of the teleiotic energies of nature. "The finest mechanical work I know," remarks Mr Kingsley, of Sidney Sussex College, "which is not optical, is that done by Robert, in the way of ruling lines. I have a series ruled by him on glass, giving actual scales from ·000024 and ·000016 of an inch, perfectly correct to these places of decimals ; and he has executed others as fine as ·000012. . . . But this is rude work when compared to the accuracy necessary for the construction of the object-glass of a microscope, such as Ross turns out. . . . I am tolerably familiar with the actual grinding and polishing of lenses and specula, and have produced by my own hand some by no means bad optical work, and I have copied no small amount of Turner's work ; and I still look with

awe at the combined delicacy and precision of his hand. It beats optical work out of sight. In optical work, as in refined drawing, the hand goes beyond the eye, and one has to depend upon the feel."* Commenting on this statement, Mr Ruskin remarks, "When once we begin at all to understand the handling of any truly great executor, such as that of any of the three great Venetians, of Correggio, of Turner, the awe of it is something greater than can be felt from the most stupendous natural scenery. For the creation of such a system as a high human intelligence, endowed with its ineffably perfect instruments of eye and hand, is a far more appalling manifestation of Infinite Power than the making of seas and mountains."†

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* *The Two Paths*, by John Ruskin, M.A., App. iv. p. 264.

† *Op. cit.*, Appendix, p. 265. I add a few additional illustrations of this evolution of these faculties by training, from the autobiography of an eminent "prestidigitateur:"—"I practised with so much zeal, and progressed so rapidly, that in less than a month I had nothing more learn. . . . . I was able to juggle with four balls at once. But this did not satisfy my ambition; so I placed a book before me, and, while the balls were in the air, I accustomed myself to read without any hesitation." (*Memoirs of Robert-Houdin, written by himself* (1859), vol. i. p. 38.) Again, "There are also cards, on the edge of which the Greek [card-sharper], when playing, makes a mark with his thumb-nail, which he can detect as they pass through his hands. . . . . I have also met persons of such practised sight, that after playing two or three games with a pack, they could recognise every card," (p. 281). "Owing to my old trade (of watchmaker), I could open a watch with ease with one hand, so as to be able to read the maker's name, without the public suspecting it" (vol. ii. p. 28). "But that power of memory which my son possessed in an eminent degree, certainly did us the greatest service. When we went to private houses, he needed only a very rapid inspection, in order to know all the objects in a room, as well as the various ornaments worn by spectators, such as chatelaines, pins, eye-glasses, fans, brooches, rings, bouquets," &c. (*Ibid.*) An instance is mentioned in which he saw

833. Now this high finish (if the term may be permitted) of the senses and the hand in one individual man as compared with another, is attained in virtue of the same general law of evolution and differentiation to perfection by which man differs in mental powers from other beings. The eye itself, however rudimentary, is a most highly differentiated organ compared with the simple ectoderm in or by which impressions are first received. Previously to the development of the organ to receive the different rays of light, this tactile sense has to be differentiated, to recognise the varying temperature which results from the presence or absence of the sun's rays; and it seems not improbable that the pigment-deposit in relation with the optic-nerve in all organisms, has in this respect the same relations to the sun's rays as the pigment-deposit in the skin of tropical races of men. And since it is a means of regulating force, it may perhaps be found that the pigment-deposit in certain portions of the nerve-centres, (and which is seen in the brain of the negro,*) has some relation to either the regulation of animal temperature or nervous force, or both. Be this as it may, the optic nerve of man is so differentiated in respect to the perception of colours, " that when we behold a red object, the retina pulsates at the rate of 480 billions of times between every two ticks of a common clock."†

834. *Differences in the Quality of Brain.*—There is a great difference in individuals as to the quality of their brains, so that men with large brains are by no means necessarily

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at a glance and remembered the titles of books in a library he passed through, in a house in the Chaussée D'Antin.

* Observed in the last century by Le Cat, *Traité de la Peau*, &c.; and last year by M. Gubler, who found it more particularly in the rachidian bulb and Pons of the negro.

† Mr Nunneley, *On the Organs of Vision* (1858), p. 39.

distinguished for their mental powers, as compared with men with smaller brains. Recent researches have enabled us to comprehend the grounds of this difference. We have seen that all mental states are the results of the transmission of vital forces according to a law of design (419, 420), operative in the substratum of mind (328). Hence the amount of force transmitted will determine the intensity of the vital and correlative mental energies. Now this must necessarily differ in amount, from several causes. First, the condition of the blood and blood-corpuscles, as to their number and their vital forces, varies much in individuals. In strumous lymphatic temperaments, they are fewer in number and less coloured than in the sanguine. Hence, *cæteris paribus*, the latter will have a more active brain than the former. And this is matter of popular observation. The word "sanguine," indeed, is applied to denote the mental character of a man who, feeling intuitively the vigour of his forces, sees no difficulties in the way of attaining his projects. Besides, there is not only in the sanguine man a richer blood, but also a larger development of lung, and of heart and blood-vessels, with greater motor power and vital activity, so that a larger amount of force is both acquired and expended in a given time. The size of lung is certainly of great importance to mental activity. It is not improbable, indeed, that a large brain in a person of a lymphatic temperament, if conjoined with especially small lungs and a large obese body, may itself be a cause of mental hebetude; for the same amount of force which would give an average mental power and corporeal vigour to a smaller brain and smaller body, is lost, as it were, in the larger.

835. Further, there are facts which tend to prove that there are differences in the material substratum of individuals, such that the rate of conduction of the transcunt

forces differs. Professor Helmholtz of Konigsberg, who made a series of experimental observations to determine this point, found that in most men the impression which causes a sensation passes to the brain at the rate of 180 feet per second; that under the most favourable circumstances one-tenth of a second was required to transmit a volition to a motor nerve, but that the rate of speed differs much in individuals, or even in the same individual under different circumstances; and that 1-100th of a second elapses after the movement is willed before the muscle contracts. The whole process requires from one-fourth to one-fifth of a second.* Now, in diseased states of the brain (as in the last stages of general paralysis), we find this velocity of transmission of force greatly diminished, so that in some instances the whole process will occupy several minutes. Slow transmission is, indeed, the most common characteristic of old age.

836. *Pathological Differences in Sensibility and Temper.*—This view of the relations of the vital force to the powers, applies also to the feelings. An abundance of force—that is to say, good blood circulating through a healthy lung, and within a healthy, well-formed brain—is correlative with a cheerful state of mental energy; but let the same man have to work in a foul atmosphere, or with his vital forces exhausted, and then low spirits, irritability of temper, and even melancholia, supervene. So that whether things shall look cheerful or not, often depends, in a man of a nervous temperament, wholly upon whether he has breathed a pure air, had a good digestion, and a good sleep (695).

837. That a morbid activity of the vessels of a part is associated with increased and even painful sensibility of

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* "Sur les Moyens de Mesurer la Pensée," Lettre de M. Ule, in *La Revue Suisse*, 15th March 1857.

the feelings, is shown by the condition of the nerves which are involved in an inflamed tissue, and which is often so morbidly sensitive that a very slight touch of the part inflamed gives pain. So also after sections of the sympathetic: with the increased activity of the circulation that results, there is also hyperæsthesia, or increased sensibility of the surface. This kind of increased vascular activity is probably the cause of the periodic activity of the generative and other instincts (684, 743), and is due to the excitor action of the ovaria and testes on the vaso-motor nerves—through the nerve-cuticle.*

838. These pathological relations are shown in certain morbid mental states. Thus, in the earliest stage of general paralysis, there is a feeling of energy. Everything, therefore, appears hopeful to the patient; large enterprises, the success of which he never doubts, occupy his mind; and he rushes sometimes into the most extravagant and wasteful speculations. This is the stage of erethism of the capillaries of the part of the brain affected, when it is just sufficient to excite increased cerebral vigour. If, however, from any cause, this activity declines so as to sink below par, a precisely opposite state of consciousness arises, and the patient may fall into a profound melancholy, and be insanely hopeless, distrustful, and anxious, as to all events—past, present, or to come. Cases marked by states of alternate melancholy and *Euphoria* (737), or both combined, are not of uncommon occurrence in asylums.

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* During the reproductive *nisus* in the spring, the nervous system of the frog is so hyperæsthetic that the animal becomes almost tetanic. Hence this period is the most suitable for experimental researches upon it. The association of epilepsy with puberty seems due to the same relation between the generative glands and the vascular system of the medulla oblongata and cerebellum.

839. Perhaps, however, this order of phenomena is best shown in those persons who experience them, and are not exactly insane. Thus Cowper the poet, who was naturally melancholic, and attempted suicide more than once, wrote the immortal farce of "John Gilpin." A man went to consult a physician for a profound melancholy which troubled him; the remedy prescribed for him was to go and see Grimaldi, the celebrated clown. "Alas!" answered the patient, "I am Grimaldi himself!"

840. Amongst the illustrations of this doctrine as to the connection between varying states of the blood and blood-vessels, may be mentioned the character of spectral illusions. These will vary in character, in the same individual, as his corporeal states vary. Thus, a person I know had first hideously grotesque and fiend-like spectres, after taking morphia when in a fever; then they changed shortly into groups of comic human faces; and finally altered to forms of the human figure, of the most classic beauty, when they ceased. Sometimes, in cases of general paralysis, the representative faculty will be modified in the same progressive way. First the erethistic condition of the organ enables the artist to work most minutely at beautiful conceptions of landscapes or figures; then, as the disease advances, he passes into the comic in art; and lastly ends in the grotesque or hideous (506).*

841. Finally, we can thus comprehend the mode in which an intensely excited and specially directed act of attention (erroneously termed by some writers Suggestion) operates in the production of mesmeric, hypnotic, and electro-biological phenomena. The person operated upon is already predisposed to irregular vascular activity, for he is usually the subject of epilepsy, hysteria, or some

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* I hope to illustrate these doctrines, at some future opportunity, by drawings, the work of the insane, and full details.

other disease, dependent essentially on an irregular distribution of the blood; or is at least of the nervous diathesis, in which there is great vascular activity in the nervous system. An act of attention, as we have seen (400), is an act of volition; but in all active mental states it is well known that there is an increased activity of the circulation through the brain. In a special act of attention, this increased vascular activity is concentrated upon one or more portions of the encephalon, according to the character of the affinitive impressions, and thus a hyperæsthesia is induced of one portion and an anæsthesia of another (728). In this way, while certain senses, as vision or hearing, may be highly exalted, others, as touch or smell, may be paralysed. And so also as to the *substrata* of the various faculties: some may be in the highest state of exaltation, others wholly in abeyance. For example, in certain states of clairvoyance, the æsthetic faculties are exalted, or the faculty of recollection is highly developed (60); in certain electro-biological states the faculty of verification (471) is abolished, and the man is at the mercy of the errant vital forces operating within his organ of consciousness. Any proceeding, then, to quote my own words written more than twenty years ago,* which will concentrate the attention of a person endowed with an affectible nervous system upon any portion of the brain, will excite that portion, but at the expense of the affectibility of other portions; and according to the degree of affectibility, the amount of excitement, and the varying powers of the organs acted on, we may have phenomena varying equally in intensity.

842. When the attention is directed to any portion of the body, innervation and circulation are excited locally, and the functional activity of that portion de-

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* *Edin. Med. and Surg. Jour.*, July 1859, Paper dated Oct. 1838.

veloped. This is well shown in the common forms of hypochondriasis, in which the patient being morbidly anxious as to the state of some particular organ (744), *e.g.* the heart, he constantly directs his attention to it, and thus functional disorder, and even structural disease, are caused. Sometimes this attention is purely automatic, as in the case lately recorded of a lady who, having witnessed an injury done to the ankle of another, very soon felt an acute pain in her own ankle, which, on examination, exhibited marks of increased vascular activity, amounting almost (apparently) to the production of something like purpura; or, in another case, of a woman past the climacteric, who, having to assist her daughter during prolonged parturition, experienced uterine pains, swelling of the mammæ, and other similar symptoms.* Something analogous to this is the case of a lady treated by Mr Braid, who drew her attention to her left breast when hypnotised, and thereby caused a copious flow of milk. Or, it is like a still more curious case given by the same writer, in which he repeatedly excited the catamenial flow at will, in a very few minutes.† In short, so well established is this law of relation between capillary activity in portions of the nervous system centrically connected with viscera and vital states of those viscera, that there can be no reasonable doubt whatever, it may be made the foundation of a scientific method of treating local diseases of all kinds.

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* My *Treatise on the Nervous Diseases of Women*, p. 112.

† See the interesting account of the late Mr Braid's experiments in his "Hypnotic Therapeutics," *Edin. Monthly Jour. of Med. Science*, July 1853.

PART VI.

PRINCIPLES OF MENTAL ORGANOLOGY.

CHAPTER I.

GENERAL DOCTRINES OF THE FUNCTIONS, MORPHOLOGY, AND STRUCTURE OF THE NERVOUS SYSTEM.

SECT. 1.—*General Functions of the Nervous System.*

843. HAVING already explained what is included under the term Mental Organology, and limited the extent to which, in the present imperfect state of our knowledge, I shall consider it in this work (549), I proceed at once to a preliminary consideration of the functions of the nervous system in general, as the organ of Mind, according to the method of examining into its anatomical and physiological relations already set forth.

844. We have seen that transference of force, or motion, is both the ultimate result and the first cause of all vital changes. A given series of changes being begun by the application of a stimulus—*i.e.*, the communication of force—they must go on until the force is expended; this occurs when the series of changes are completed, or,

in other words, when the ends to which the series are adapted are attained. Now, the nervous system is essentially an apparatus expressly constructed to be the seat of this class of vital changes, so that the two great phenomena of Life—motion to ends, and consciousness—shall coincide (419). What kind of motion and what states of consciousness shall occur and concur upon the application of a stimulus, depends upon the kind of stimulus applied, and the nature of the apparatus to be moved or to be conscious of; and these, again, depend upon the particular ends aimed at in their use as stimulus and apparatus.

845. But the nervous system is not simply an apparatus whereby the causal changes subserving to adapted motion and to consciousness shall take place; it has the more especial function of combining an infinite variety of such changes into subordinate and general unities, so that One general result shall follow upon the Many series of phenomena. Such a combination is effected, in the perception of an object, when an infinite variety of impressions are so combined as to constitute the one perception (470, 471); or, in volition, by the combination of a multitude of changes in a muscle into one muscular contraction, and by the combination of many muscles into one act (402, 832). In both instances multiplicity is reduced into unity; the Many constitute the One. In this special property of the nervous system, we have, however, only a manifestation of a power common to all living tissues. It is a general function. It therefore includes all the special functions by which that end of organismic unity is attained. Or, in other words, the nervous system is subject to the same vital laws, as to development, nutrition, assimilation, and the like, as all other tissues.

846. Yet the nervous system, considered as the co-ordinating apparatus whereby the changes which occur

everywhere in the body are unified, is not at the same time to be taken as the immediate cause of those changes—*i.e.*, as the source of the vital forces by which they are induced. Motion to ends, growth, nutrition, assimilation, and the like, go on in virtue of the forces inherent in the tissues themselves—these the nervous system co-ordinates into unity of action. Hence the most important and fundamental principle in neurology, that the forces resulting from the nervous system itself are in the nature of a dynamical stimulus to vital changes, in virtue of which the forces requisite thereto are evolved; just as a transference of force from matter, in the shape of an external affinitive impression, is a dynamical stimulus. Hence the so-called *vis nervosa*, transmitted from the ganglionic centres, is an affinitive stimulus to fitting changes in the tissues—*i.e.*, the adapted production and transference of force, but not necessarily the force itself by which these changes are effected. It is therefore analogous to the forces of heat, light, chemical affinity, and the like, which, when received directly from appropriate things, as affinitive impressions, by the living tissues themselves, excite vital changes therein. The difference, therefore, is, that where there is a nervous system, these affinitive impressions, coming through appropriate organs of reception, act first upon its co-ordinating mechanism, and through it upon the tissues. Now, the fundamental co-ordinating apparatus is probably the nerve-cell.

847. This law of nerve-function is abundantly proved by the infinite variety of phenomena which occur both in plants and in animals (602, 634) devoid of nerves. One of many striking illustrations of it is afforded by a phenomenon which has occupied much of the attention of physiologists—namely, the rhythmical contractions of the heart. Rhythmical contraction is seen to

take place in structures devoid of nerves, as in the *Hedysarum gyrans*, in Spermatozoa (647), in Oscillatoriæ (654), in the simplest form of blood-vessel in invertebrates, in the heart itself, when constituted of cells only. All this happens in virtue of a fundamental law of rhythmic vital action (222–224). When, therefore, these contractions are excited in the fully developed organ, with its free supply of nerves, by the "*vis nervosa*" derived through or from them, they are not the result of that stimulus acting as a source of power, but only of it acting as an affinitive impression, and therefore according to the same law as other stimuli of the kind, applied immediately to the contractile tissue. The proper function of the nervous system is to co-ordinate, direct, and intensify that transference of force upon which the contractility depends, so that the heart's action shall be in fit relation with the rest of the organism, and not to supply the force itself.

848. Further, while all vital phenomena whatever are due to changes in the tissues (and the blood must be looked upon as organised—as fluid flesh), no change in these occurs spontaneously, that is to say, independently of a preceding change. And all such changes, however intricate, may be traced back finally to some transference of force derived from without—that is, to an external *stimulus* to change. Now, the nervous system is a recipient apparatus for these stimuli—*i. e.*, for the various molecular forces operating upon the organism from without (418)—and as such is in relation with varied mechanical arrangements adapted to the reception of those forces. These are the recipient nerves of the surface of the body and the senses, and their appropriate organs. The simplest form is that in which the nerves of a sphincter muscle like the iris, act so as to induce contraction of it when a

stimulus (as of light) is supplied; the most complex is the organ of vision in man, in which the optic nerve is in relation, as recent anatomical researches prove,* and as all mental phenomena render certain, with the entire hemisphere, and through these with the entire nervous system.

849. If, then, we look at the nervous system generally, as regards its special functions of co-ordination, it is homologous with those living tissues which have this property so characteristically, that every fragment can co-ordinate its constituents into action independently of the entire portion. If we compare one portion of the nervous system with another, as regards its general functions of adapted response to stimuli, then the nerve of a sphincter is homologous with a nerve of special sense.

850. Having thus a clear conception of what the functions of the nervous system really are, let us proceed to examine its operation as a co-ordinating apparatus in different organs and organisms. We might select for this purpose either the distribution of the blood (the circulation), or the changes known as secretion and nutrition; but the most easily followed are the phenomena of muscular action, or voluntary and involuntary motions of the organism as a whole, or of its movable parts. In this series of phenomena we can examine the whole procedure, from its commencement with the application of an external stimulus, the propagation of that stimulus to the co-ordinating centre, and the transference thence to the moving apparatus of the *vis nervosa*, considered as an affinitive force (418). We can trace up the various apparatus from their simplest evolution to their most complete manifestation as the union of multitudinous phenomena into one phenomenon—visible motion.

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* M. Gratiolet. *Anatom. Comp. du Système Nerveux*, p. 179.

851. We have seen that the simplest form of organism is that in which there is a mass of cells in relation to each other, as in the Actinophrys or Amæba (707). Let us pass from this to a higher organisation, such as the Hydra Viridis, which is a polype with the power of locomotion. Although wholly without discoverable nerve or nervous system, it moves like a leech; first fixing itself by the tentacula around its mouth, and then, by the contraction of its body, drawing forward the posterior extremity, and fixing it near the anterior by means of a disc or sucker-like apparatus. But it can also leap or throw a sort of somersault, by which it projects the tail over and beyond the head—and this also by the contraction of its body; and finally, it can convert its tail into a sort of flying or floating apparatus, for, by moving to the surface of the water in which it lives, it can project its tail into the air, so as to dry it, and it then becomes a hydrostatic apparatus, which, acting as a float, enables the animal to move along the surface of the water with its oral extremity downwards, ready to seize its food.* This kind of activity is very generally seen in the lower organisms. Thus the Edwardsia or Synapte, a holothuroid animal, not only moves like an annelid, although apparently devoid of nervous system, but, on very slight irritation, it will vomit a portion of its intestinal canal, which in its turn will move in the water, deviating when opposed as if endowed with consciousness, so that it might be easily mistaken for a worm.†

852. These kinds of organisms are all apparently homologous with the Hydra, as that is homologous with a

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* Mr Bishop, in his interesting essay on "Motion," *Cyclop. of Anat. and Physiology*, vol. iii. p. 433.

† M. Quatrefages. *Ann. des Sciences Nat.*, 2e Series, "Zoologie," tom. xviii. p. 73.

simple cell and its two membranes. Consequently the body of this class of animals is homologous with the *contenta* of the cell, and the endoderm and its tegumentary covering with the ectoderm. In this way we have two fundamentally homologous structures, both having similar functions of external relation, the one to the *contenta*, the other to external things proper. As they are differentiated, organs of prehension and alimentation, mouth and gastric cavity, are evolved internally; of aëration (lungs), motion (limbs), and defence externally. In the Holothuria and similar animals, a parenchymatous structure intervenes between them, termed the perigastrium; and it is out of the analogue of this that we have the series of longitudinal, transverse, and circular muscles of the annelids developed, the muscular system of insects, and finally the voluntary system of vertebrates, including both the trunk (or the walls of the visceral cavities) and the limbs attached to it.

853. Now, in the phenomena of all these motor structures of living things, there is the same general law operative as in cardiac action. The motor tissue, whatever its use, is so constructed that it needs only a force-stimulus to be applied, which shall excite the evolution and transference of the force stored up in its tissue, or in the fluid that circulates through it; that is, any appropriate stimulus—whether it be a mechanical or mechanico-chemical force. Its capacity to receive this force adaptively is none other than its property of contractility. When, therefore, the muscular fibre receives an affinitive impression through the motor-nerves from the central axis, the *vis nervosa* takes the place of an external force-stimulus, in so far as it is a cause of the development and transference of force in the muscle, and is therefore not the power by which contractility and motion are directly induced. Its property

is to co-ordinate and direct the contractility and transference of force, or multitudinous fibres and cells, to one common end.

854. The same law applies to the more complex evolution of the tissues into organs. When differentiation is more active, a special respiratory apparatus is constructed, which is either an intus-susception, more or less complex, of a special portion of the ectoderm, or a differentiation of the endoderm. The latter is also the rudiment or general homologue of both the stomach and alimentary organs generally, and the entire series of internal glandular structures, whether salivary, gastric, hepatic, or intestinal; while from the ectoderm, or tegumentary system, the glandular structures of the skin, the defensive coverings, and the instruments of locomotion in the invertebrate, are developed.* The vascular system is developed either between the gastric pouch and parenchymatous body as a perigastric cavity, or in the substance of the latter, in animals with the blood not highly differentiated; but in those in which the blood corpuscles are more highly evolved, we have a correlative motor and dynamic apparatus in the vascular system proper and the capillaries. Each of these specialised tissues and organs have their proper vital forces independently of the nervous system; and their functions can be resolved into motion or transference of force to end, on the direct application of stimuli, independently of a nervous system; but when that is developed, then their functions are co-ordinated by the *vis nervosa* which develops their vital activity in co-ordination with and in relation to the functions of other parts (677).

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* Compare Mr Bowman's instructive article, "Mucous Membrane," in *Cyclop. of Anat. and Physiol.*, vol. iii., in which the homology of the skin and mucous membranes is lucidly developed.

855. These principles enable us to arrange the proper functions of the nervous system as a co-ordinating apparatus, operating by means of an affinitive transference of force, whether in sensation or in motion. If we conceive a nervous system constructed according to them, it would have two kinds of functions: *First*, A general function, by which it develops and unifies the processes of all the tissues; and, *secondly*, A special function, limited to special tissues, adapted to special ends. These may be grouped under five distinct systems, with reference to these points, as follows:—1. A stomato-gastric system, to co-ordinate the organs of prehension of food and alimentation; 2. A respiratory, to co-ordinate the aërating structures; 3. A vaso-motor, to regulate the distribution of the nutrient and aërated fluid; 4. A trophical or nutrient system, to regulate all the changes of assimilation and nutrition, and the form and functions of parts, so that they be in accordance with the archetypal morphology and idiosyncrasies of the animal; and, 5. A co-ordinating centre to combine all processes to their proper ends as parts of a whole. In this last-mentioned there would be two distinct elements; namely, that in which the co-ordination takes place, and that from which the dynamic stimulus passes, or the centres of sensation and motion. These, then, are the functions of the nervous system, and of its parts. Can we connect these with the structure and form they assume, or, in other words, determine the morphological homologies and anatomy of the nervous system?

SECT. II.—*The General Homologies and Anatomy of the Nervous System.*

856. So soon as comparative anatomy and zoology

were sufficiently advanced, attempts were made to ascertain the anatomy and functions of different portions of the nervous system by dissections and experimental researches on lower animals, and by theories of development of parts. But it was necessary to determine, in the first instance, what particular parts in animals corresponded to certain other parts in man. There were two modes of doing this: 1*st*, Those portions might be concluded to be identical which subserved to the same functions, and co-ordinated identical tissues; and, 2*dly*, The nervous system as a whole, or its parts, might be compared with reference to form and anatomical composition in man and lower animals, and the identity established by the comparison of resemblances. But it soon became manifest that the same function was performed in animals by very dissimilar structures; and hence the necessity arose of distinguishing between what was identical in function only, and what in both function and structure. Thus the wing of a bird is a motor instrument having the same function as the wing of an insect—namely, locomotion through the air—but it is not of the same structure. On the other hand, however, it has both the same general function—that is, locomotion—and the same general structure as the pectoral fin of a fish, the fore-leg of a quadruped, and the arm of a man.

857. In his Hunterian lectures, Professor Owen has distinguished these general laws by special terms, which have been commonly accepted by physiologists. The functional resemblance alone, is termed by him an "Analogy;" a structural resemblance, a "Homology." An "Analogue" is therefore "a part or organ in one animal which has the same function as another part or organ in a different animal;" and a "Homologue" is "the same organ in different animals under every variety of form

and function." A little consideration will show, however, that in these doctrines we encounter the old philosophical difficulty of the Universal and the Particular (91, 92). The functions of the nervous system aim to fulfil an idea; viz., the co-ordination of the parts or organs of an organism into one. Now, this ideal end, we have seen, is attained by a great variety of structure—indeed, by every variety of structure; for the co-ordination of parts or organs is the primary function of all tissue, as it is the very essence of life. Hence Oken maintained that the nerveless animals are in fact all nerve.* But we may go farther, and say that a definite structure is not at all necessary for the manifestation of the co-ordinating force, if we take development as well as functional activity into consideration. And this it is obvious we must do; for co-ordination is shown as much in the formation or growth of structures—that is, their co-ordination in Time—as in their action, their co-ordination in Space. From this point of view, the highest co-ordinating powers are manifested by the sperm-cell and germ-cell, since their vital affinities are continued in a long and multiform series of the successive adaptations termed Life. They are the atomic elements of the vital forces (297), in which a general, universal, and necessary law of life correlates all the particular derivative and contingent laws. The same remarks apply to the special or minor ends for which structures are developed, as alimentation, aëration, generation, &c. The correspondence of organ and function as to each is nowhere permanent, but is ever as fleeting, variable, and contingent, in the infinite variety of vital phenomena, as the thoughts themselves in mental life (179). The ends only are fixed and certain; the means vary widely, as to form, structure, and intimate composition.

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* *Lehrbuch der Natur Philosophie*, 2d edit. (Jena 1831), p. 256.

858. It is not surprising, therefore, that differences of opinion arise amongst philosophical zoologists as to the principles upon which homologies should be determined. We have, in fact, the same two great antagonistic classes in this as in the class of psychological philosophers or metaphysicians. The one takes for examination the fixed and absolute series of successional phenomena, and applies to them the doctrine of "archetypal" ideas—the "innate" ideas of the metaphysician; the other selects the mutable and contingent phenomena, and applies to them the *à posteriori* method and doctrine of experience. Yet the methods are not, in truth, antagonistic; they are only imperfect in proportion as the one excludes the other.

859. To bring both into relation, we have to adopt the method already developed in our Mental Dynamics and Psychology, and pass from the general to the special, as derivative of the general. To this end, therefore, we determine, in the first instance, the teleiotic homologies of organisms (607), disregarding the variations in form and structure which arise as the teleiotic ideas are evolved. For example, while there can be no homology, in the ordinary sense of the term, between the so-called "brain" of an insect and that of man, inasmuch as the anatomical relations of the two organs are wholly different—the one being the co-ordinating instrument of organs in connection with an external or dermal skeleton, and the other of organs in connection with an internal skeleton—there is a teleiotic homology; for whether the locomotive apparatus be derived from the integument or not, and however the viscera may be anatomically placed in relation thereto, the same ends are aimed at and attained.

860. As we descend the scale of organised life, and reach tissues which are little differentiated—*i.e.*, which have general functions—in the same proportion ana-

tomical and morphological characteristics fail as the bases for homologies, because speciality of functions requires special tissues; and as these alone determine special forms, we must have recourse to telciotic homologies wholly. On the contrary, as we ascend the scale of organised life, we can establish our homologies on morphology and anatomy; for form and structure are more distinct and permanent as tissues are differentiated and numerous relations evolved. Thus, there is no difficulty in determining the homologies of the highly differentiated phanerogamous plants, or of the complex and highly-developed Articulata. Thus it is that in all vertebrates the vertebræ are demonstratively homologous; consequently, we can infer that the segments of the ventral axis corresponding to each vertebra are homologous, together with the symmetrical ganglia on the posterior roots. But it by no means follows that the ganglia or segments of the central axis of the invertebrates are homologous with the *medulla spinalis* of vertebrates, inasmuch as it has yet to be proved that the skeleton of insects is homologous with that of the latter.

861. In man and the vertebrates, we have five different divisions of the nervous system to examine, if we take the morphological classification; namely, 1. The chain of ganglia termed the Sympathetic system; 2. The symmetrical chain of ganglia, situate on the posterior roots of the spinal-nerves, for which I will adopt the term used by French writers—namely, the intervertebral ganglia; 3. The nervo centres, occupying the vertebral column or spinal cord; 4. Its prolongation within the cranium, or the *medulla oblongata;* and, 5. The "brains," including both cerebrum and cerebellum. The telciotic classification (607) would be in correlation with these; namely, the sympathetic is to be taken as the system

which develops and unifies the processes of all the tissues; the pneumo-gastric system, as that which presides over the stomato-gastric and respiratory system. A special centre for the systemic circulation must be separated from this system, for the right side of the heart only belongs to the respiratory. That there is some difference of this kind is obvious, from a consideration of the general laws of function and nutrition of the venous and arterial system. The veins are passive hydraulic tubes, the arteries active contractile tubes: the arteries undergo calcification and other changes in nutrition; the venous system proper is rarely if ever the seat of these changes. The intervertebral system is perhaps (as I shall give reasons for thinking) that which, by directing the nutrition of the cerebro-spinal centres, influences the form and function of the body and its organs. The cerebro-spinal axis is the great co-ordinating centre of the whole, with its divisions into the *medulla spinalis*, the *medulla oblongata*, the *cerebellum*, and the *cerebral ganglia*. The functions of all these must be considered as twofold—namely, those of adaptation and of dynamization; which again are divisible into two, as they are coincident with consciousness, the volitional and sensory systems,—or not coincident, the automatic and involuntary.

CHAPTER II.

THE DYNAMIC AND STRUCTURAL ELEMENTS OF THE NERVOUS SYSTEM.

SECT. I.—*Nerve and Nerve-cell, as Elements of the Nervous System.*

862. No zoologist or comparative anatomist doubts that animals may be very completely organised, and yet not present a trace of a nervous system. Still not a few physiologists cling to the idea, that wherever an animal acts to ends in the same way as man and the higher vertebrates, there must be a nervous system present, whether cognisable or not. Now, it is conceivable, and even probable, that there may be a teleological differentiation of cells in the tissues of both plants and animals, such that they perform the same functions as the nervous system, and yet no difference in structure be cognisable. This conclusion would only be in accordance with the general homogeneousness of their organisation. And it is in accordance, too, with all analogy, to infer that the first trace of a nervous system would be a series of cells, united by internuncial filaments, or placed in contiguous relation. Such, indeed, seems to be the lowest form of the nervous system in the Rotifer, *Lacinularia socialis*, in which, according to Leydig, there are two groups of spindle-shaped cells, one situated between the pharynx and ingluvies (corresponding to a stomato-gastric system), the other

near the tail (the larger group), and probably motor. These cells are attenuated, and elongated into five (nervous) filaments.* In this arrangement, we have the two essential elements of the nervous system—namely, the ganglion, or a group of nerve-cells, and the internuncial filaments.

863. *The Nerve-Fibril.*—It is conceivable that the nerve-fibril is evolved by integration out of a primary group of cells like that just described, just as capillaries are believed to be integrated out of blood-corpuscles, and muscular fibrils out of motor-cells. Be this as it may, the so-called nerve-fibril is a tube, within which there is a central fibril or axial cylinder, surrounded by a *medulla* or sheath, which is a semi-fluid, fatty, albuminous pulp. The nerve has apparently the same vital properties as the nerve-cells; for when an affinitive impression is made upon it, the transference of force goes on along it, as if its elements were serial repetitions of each other. So that if the transference of force be begun in any part of its course by an affinitive impression, it continues onwards; and the same change occurs in the tissues where the wave ends, whether ganglionic or not, as would have occurred if the impression had been received at the origin of the nerve—*i.e.*, either at the periphery or centre. Thus, if a motor nerve be irritated anywhere in its course, motion results in the tissue to which the nerve is distributed; if a sensory nerve, a corresponding sensation is referred to the tissue from which the nerve commences. Mechanical and mechanico-chemical forces are in affinity with the sensory and motor nerves given off from the spinal cord, and the mechanico-chemical with the cerebral nerves; but they are not in affinity with the cerebellum, cerebrum, and its connected ganglia;—transeunt forces,

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* Professor Owen. *Lectures on the Invertebrata*, 2d ed., p. 47.

that is, forces derived from mechanical and chemico-mechanical forces operating through ganglia, are alone in affinity with these (419).

864. The nerve-fibrils differ in size. The larger white fibrils are more numerous in the anterior spinal nerves, and fewer in the posterior. The smaller white nerve-fibrils are also most numerous in the sympathetic; they reach their utmost fineness in the grey matter of the hemispheres.* The grey or *gelatinous* nerve-fibrils are distinguished from the kind just described, by being present in greatest numbers in the Sympathetic system, and by being much finer, and of a gelatinous consistence. They are described by Remak, their discoverer, to be destitute of sheath, naked, and transparent, and as breaking up into delicate fibrils, which present oval swellings or dilatations, together with a number of round, fusiform, or oval corpuscles, arranged upon them at intervals. They are more abundant in the grey-looking portions of the sympathetic. They are the main elements of the sympathetic nerves which accompany the carotid arteries, of the cardiac nerves, the nerves of the blood-vessels in general, the branches connecting the large ganglia and plexuses in the abdomen, and the pelvic plexuses. They are particularly abundant (Remak states) in the nerves of the unimpregnated uterus.†

865. These grey or gelatinous fibres of the sympathetic would appear to be more homologous with a series of internuncial cells than with the ordinary white nerve-fibrils. The homologies of nerves and nerve-cells require, however, a special investigation, which has become possible since the discovery, by Professor Gerlach of Erlangen

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* Kölliker. *Manual of Histology*, Sydenham Society's translation, by Messrs Burt and Huxley, vol. i. p. 42.

† Kölliker. *Op. cit.*, vol. i. p. 483.

and Mr Clarke, of the affinity of the nerve-cells for colouring material, especially carmine; this is absorbed by the cells, while the granular matter in which they are embedded remains unchanged. Messrs Lister and Turner have applied this method to an examination of nerves, and they find that the axial cylinder of a fibril from the sciatic nerve of a cat absorbed carmine, after being treated by chromic acid, whereas the medullary sheath did not.* This would tend to show that there is some resemblance, in composition at least, between the nerve-cell and the axial cyclinder, which, in fact, comes from it.

866. The function of nerve-fibril, wherever it may be, is essentially internuncial; but it is nevertheless co-ordinating also. It establishes a communication between tissue and tissue; between one nerve and another; between cell and cell; and, as the essential element of white commissures, between one ganglionic mass of cells and another. But it is to be noted that the internuncial and co-ordinating function is not unfrequently increased by the addition of nerve-cells to the nerve-fibrils, or at points where they join, or of groups of cells in the commissures (striated commissures) constituted by them. The nerve-cells of nerves are to be found in the course of the motor nerves, and at the origin of the sensitive. Nerves with cells are designated *Ganglionic nerves* by M. Duvernoy.† Motor nerves connected with the encephalon are in this class. Rosenthal and Purkinje found them in the trunk of the oculo-motor of the Ox; the facial nerve, in its gangliform enlargement, has a number of large nerve-cells. In the root of the hypoglossus in the Mammalia, according to Bidder, there are not unfrequently isolated nerve-cells. Nerve-cells were

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* *Journal of Microscopical Science*, Oct. 1859.

† *Comptes Rendus*, tom. xxxv. p. 120.

found by Leydig in the angles of branching-off nerve-fibrils of the *Carinaria Mediterranea.* Probably further researches would multiply the number of ganglionic motor nerves. The nerve-cells at the origin of sensitive nerves seem to correspond with those on their course or at their central termination. Thus the rods of the retina rest on nerve-cells.* The same appears to be true of the cells discovered by Corti in the cochlea of the ear. According to Ecker, the olfactory nerves begin from nerve-cells; and Schr. V. der Kolk is of opinion that the recent discoveries of R. Wagner and Meissner, of the *corpuscula tactûs*, tend to show that the cutaneous nerves of sensation arise from something analogous to nerve-cells.† These *corpuscula* seem, however, to be more analogous to the retina rods.‡

867. *Nerve-Plexuses.*—To fulfil their internuncial function, the nerve-fibrils interlace with each other, both within and without the ganglionic centres. This is the case with the spinal nerves; but more especially with the sympathetic, which is evolved into a series of plexuses. This arrangement of the fibrils of the sympathetic corresponds probably to the arrangement of the nerve-fibrils within the spinal cord; the difference consisting in this, that the plexuses of the latter are integrated with the ganglionic masses of cells into a continuous structure. Plexuses also form when nerve-fibrils of different systems are to be co-ordinated (fig. 2).

868. *Nerve-Cells.*—The nerve-cells vary much in size,

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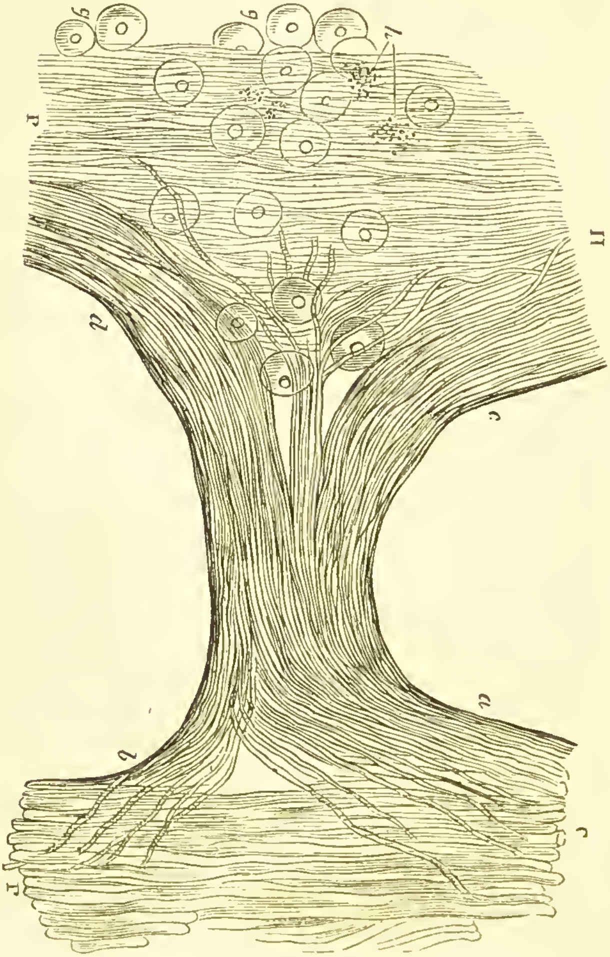
* J. C. Müller, *Anatom. Physiolog. Untersuch. über die Retina.* 1856. Mr Nunneley, *On the Organs of Vision*, p. 213.

† *On the Spinal Cord*, Translation of New Sydenham Society, p. 137.

‡ R. Wagner, *Neurol. Untersuch.*, p. 145. Gerlach, *Microscop. Studien* (1858), p. 50.

form, colour, and connections. They are not, however,

Fig. 2.



Branch of communication between the sympathetic and third spinal nerve in the Frog, showing the arrangement of its fibres at the point of junction. (After Bidder and Volkmann.)*

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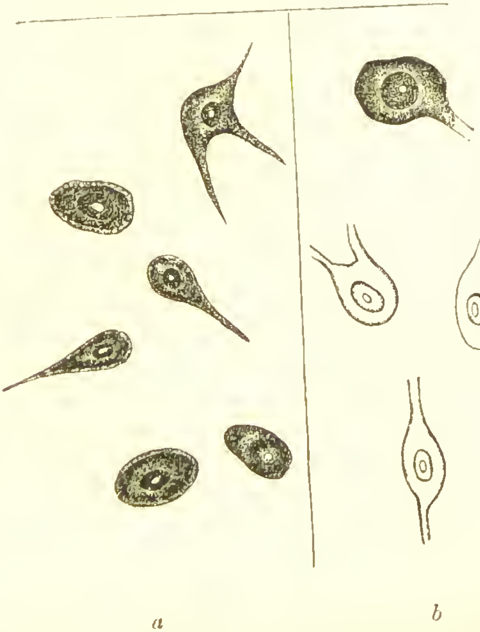
* H P, Sympathetic nerve; H, cephalic side, P, pelvic; C P spinal nerve; C, its cephalic, P, its pelvic or peripheral end. *a*, Portion of communicating branch running centrically; and *b*, portion running peripherally; *c*, fibres running upwards in the sympathetic; *d*, fibres running towards the pelvis: *g g*, ganglion-cells; *h*, pigment.

peculiar to the central grey matter, or to the ganglia, since, as we have seen, they are found on the peripheral expansion; in the trunks; and at the points of union of nerves in plexuses. They seem to be constructed, histologically, like the nerve-tube, in so far as they consist of a membranous cell-wall containing a semi-fluid pulp essentially like that of the nerve-tube. They contain, however, in addition, a nucleus; and this again a nucleolus and pigment-deposit, varying in quantity and colour.

869. One or more fine filaments or processes pass from most of them, which are either continuous with the axial cylinder of a nerve or with the processes of other cells. Those without any process have been termed by Stannius

Fig. 8.



Variously formed ganglionic cells from human *medulla oblongata*. *a* from the post-pyramidal ganglion; *b* from the restiform ganglion; × 420. (After J. Lockhart Clarke.)

apolar, while others are named unipolar, bipolar, or multipolar, according as the number of processes is one, two, or more than two.

870. The nerve-cells in the sympathetic ganglia are of all kinds—apolar, bipolar, multipolar—but most numerously multipolar; the number of processes varies between three and twelve; they manifest the optical and chemical properties of the axial cylinder of the nerves with which they become continuous.* The processes of the bipolar cells branch; they are therefore virtually multipolar. The ganglia on the posterior roots of the spinal nerves contain apolar, unipolar, and bipolar cells, but principally bipolar, the filamentous processes being at opposite poles of the cell-sphere. The one pole is believed to be directed to the periphery, and the other to the central axis.† Some of these cells are unipolar, but with a bifurcation of the filament, as in the unipolar cells of the sympathetic and of the restiform body (fig. 3, p. 349).‡ The discussion as to the conducting property of these bipolar cells has led to the opinion that the simply unipolar are really bipolar, from which one of the processes has been broken off.

871. The cells of the *Gasserian* ganglion, one of the intervertebral chain, resemble those of both the spinal and the sympathetic ganglia; but some appear to differ as to the number of nuclei they contain (fig. 4). The cells of the intervertebral ganglia often contain, in the vicinity of their nucleus, an accumulation of yellow, yellowish-brown, or large pigment granules, which increases in quantity with age.§

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* Remak. Translation of paper, *Edin. Monthly Med. Journal.* April 1854.

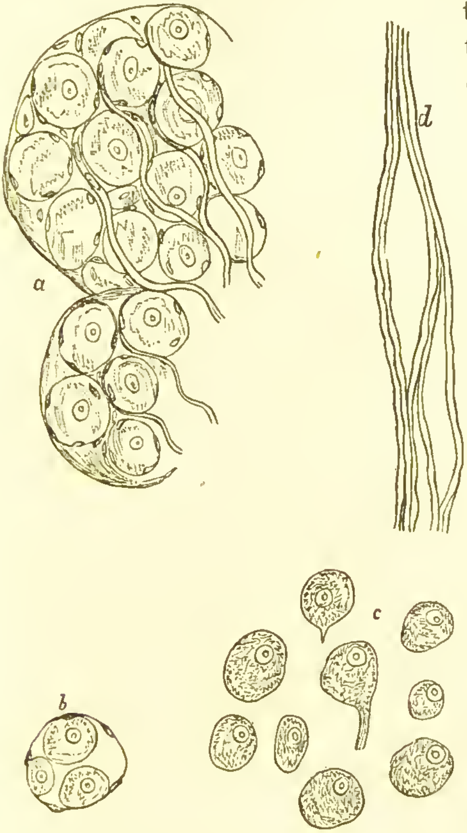
† R. Wagner. *Neurolog. Untersuch.*, p. 6.

‡ Compare also R. Wagner, *op. cit.*, plate ii. fig. 6.

§ Kölliker. *Op. cit.*, p. 462.

872. The cells are larger and more numerous in the anterior grey matter of the spinal cord than in the posterior.* They are of various sizes, but remarkably multipolar, and intimately connected with each other and with the roots of the spinal nerves by means of their numerous branching processes.

Fig. 4.



From the Gasserian ganglion of an embryo calf 18 inches long. *a*, Portion of ganglia with corpuscles *in situ*; *b*, three corpuscles included within one cell; *d*, nerve-tubes connected with the ganglia.

873. The gelatinous substance of the spinal cord contains nerve-cells of various shapes and sizes. The large cells are more or less oval, pyriform, fusiform, crescentic, triangular, or irregular; they contain distinct nuclei, and give off processes from two to five or six in number. Some of these processes

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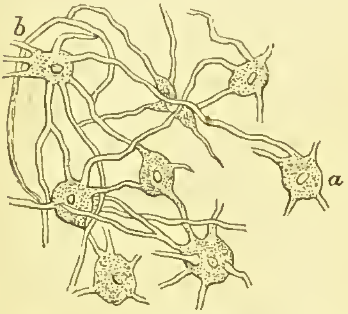
* Compare Professor Sch. Van der Kolk, *On the Minute Structure and Functions of the Spinal Cord and Medulla Oblongata*, Sydenham Society's Translation. Lond. 1859.

appear to terminate in one or more of the semicircular or marginal fibres of the gelatinous substance; some run backwards through the posterior columns, or forward across the gelatinous substance; others pass longitudinally with the fibres of the latter, or along the verge of the posterior columns. These nerve-cells thus appear to be more or less continuous with the various fibrils of the spinal cord. The small cells give off two processes. The oval and fusiform kinds, like the preceding, are elongated transversely, longitudinally, and obliquely, near the border of the posterior columns; but through the rest of the gelatinous substance the longer axes of many, as well as their processes, are parallel to the antero-posterior fibres that form the posterior roots of the nerves, with which they are apparently continuous. The cells of intermediate size are found chiefly near the verge of the posterior columns.*

Fig. 5.



Part of a group of ganglionic cells from the anterior horn of the lumbar portion of the spinal cord of a cow (longitudinal section), showing the numerous fibres of connection; *a*, *b*, an unusually long communicating fibril. (After Sch. Van der Kolk.)

874. The cells of the olivary bodies, situate in the *medulla oblongata*, have been described by Mr J. Lockhart Clarke. These ganglia (which bear a striking resemblance under the microscope to the cerebral convolutions) contain cells unipolar, bipolar, and multipolar, of small but uniform size, varying greatly in shape, according, apparently, to the number, relative distance, and direction of their processes (see fig. 6). These are generally

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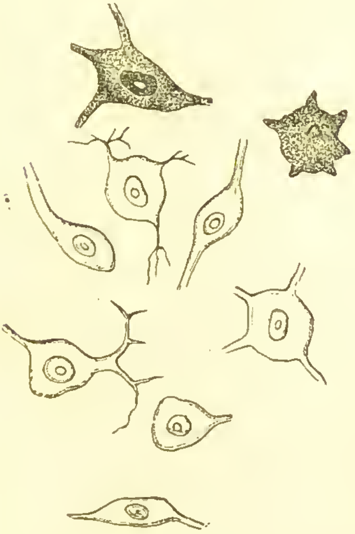
* Mr J. L. Clarke. *Phil. Trans.* 1859, p. 441.

numerous, extend in different directions, or divide abruptly into several branches, which become continuous with the nerve-fibres.*

875. The cells of that portion of the *medulla oblongata* which Mr Clarke has termed the post-pyramidal and restiform ganglia, have been already figured (fig. 3). Each cell of the post-pyramidal nucleus or ganglion contains a distinct nucleus and nucleolus, with a mass of pigment-granules accumulated on one side or at one extremity. The cells of the restiform ganglion are precisely similar in structure and shape to the preceding, but are of larger size. The cells in relation with the auditory nerve at its origin are of unusually large size, and as fibres from the cerebellum are in connection with its ganglionic nucleus, it probably subserves, as Sch. Van der Kolk surmises, some reflex motor function.†

Fig. 6.



Cells from the human olivary body, magnified 420 diameters. (After J. L. Clarke.)

876. *Nerve-Cells of the Convolutions of the Cerebellum.*—Professor Gerlach has made some interesting researches into the microscopic structure of this tissue.‡ A thin section shows three distinct elements: First, the white

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* Mr J. L. Clarke in *Phil. Trans.* 1858, p. 243.

† *Op. cit.*, p. 124.

‡ *Microscop. Studien*, &c. Erlangen, 1858.

Fig. 7.

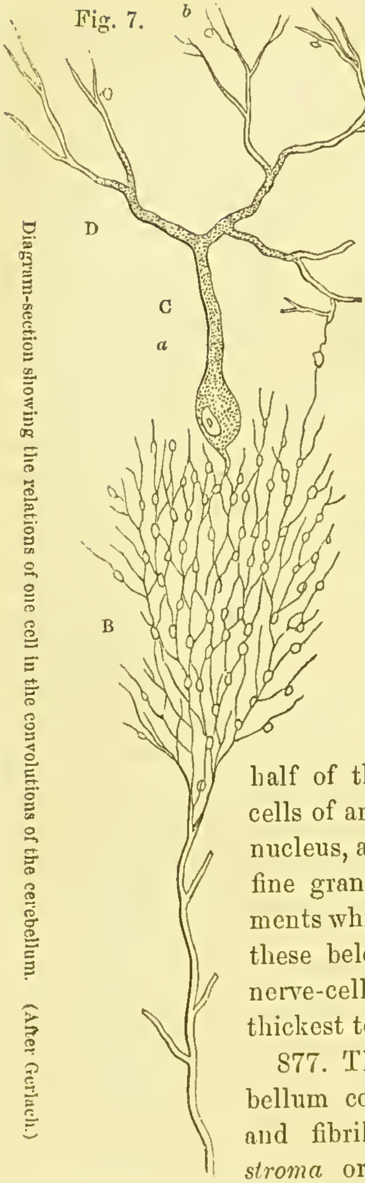

Diagram-section showing the relations of one cell in the convolutions of the cerebellum. (After Gerlach.)

substance consists of nerve-fibrils (Fig. 7, A) which radiate towards the grey substance of the convolutions, C, becoming finer as they approach it. Above the layer of these nerve-fibrils there is a layer of free nuclei or granules, B, with which the nerve-fibrils are connected by remarkably fine fibrils. The granules vary as to the number of fibrils attached to them, but it is not unusual to see them with three. Besides these granular elements, there are found in the external half of the granular layer minute-cells of an oval form, with a cell-like nucleus, and distinct nucleoli. Their fine granular contents, and the filaments which they give off, prove that these belong to the class of centric nerve-cells. This granular layer is thickest towards the convolutions.

877. The grey layer of the cerebellum consists of cells, granules, and fibrils, embedded in a fine *stroma* or granular substance, not unlike the contents of nerve-cells.

The nerve-cells proper of the cerebellum are situate between these layers of granules. The most recent researches by H. Müller, Kölliker, and Gerlach, have proved that the cells of the retina are in connection with granules by means of their processes. Gerlach found the order of things similar in the cerebellum.

878. There are two classes of cell-processes—the principal stems and the fine branches. The fine branches are in connection with the granules *b b'*. These processes are numerous, and directed to the periphery of the convolutions, where they anastomose freely with each other. A fine filament—sometimes two—runs from the opposite pole of the cell to the granular layer B, to join a granule. The cells have very distinct membranous walls, and contain a granular matter wholly devoid of pigment.*

879. *Nerve-Cells of the Cerebral Ganglia.*—R. Wagner has figured cells from various portions of the cerebral ganglia. They differ as to size and connections, but they are all, without exception, large multipolar cells, containing granular matter and a nucleolus. They are embedded in a fine granular substance or stroma, which is abundant in proportion to the number of capillaries that enter it, and is thickest in man on the surface of the convolutions

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* One of the preparations, it ought to be stated, was from a girl aged 8, another from an adult man.

Description of Fig. 7.—A, White layer of nerve-fibrils; B, granular layer, the granules connected with each other by fine processes; C, cell-layer, or grey matter; C, peripheral matter; D, Peripheral branching processes of the cell *a*. This is bipolar: at the one pole the processes branching towards the surface of the cerebellum; at the other, or central pole, the process joins the fine filaments of the granular layer; *b b'*, fine branches of the cell-processes uniting with granules.

and in the *substantia perforata* at the base of the brain. This substance is wholly wanting in invertebrates with ganglia devoid of capillaries, as the Nematoids,* but it is found in the leech and earthworm. Wagner thinks its use simply mechanical—namely, to form a bed for the blood-vessels, so that they shall not injure the delicate nerve-cells. This hypothesis is, however, very doubtful; his other hypothesis—that it is the matrix out of which cells are developed—is more probable. The processes interlace with each other; and some cells are united like chain-shot by a thick process passing between them. This was the case with cells taken from the *substantia ferruginea* and the *locus cœruleus*. The connections of the cell are very similar, in fact, to those of the cells seen in the nucleus of the vagus, which subserve to the functional activity of the electric lobes in the torpedo. The primitive nerve-fibrils are classed by Wagner in five classes; they vary from one two-hundredth to one thousandth of a millimetre in thickness. The finest are most commonly, if not exclusively, found at the origin of nerves.†

880. *Pigment-Deposit in Nerve-Cells.*—The preceding descriptions mention the presence of pigment in nerve-cells. Several portions of the nerve-centres are remarkable for the amount of pigment-deposit in the cells which constitute them, and have received distinctive names in consequence, as the *locus niger* of the brain. No theory of this pigment-deposit has been as yet adduced sufficient to include all the facts. It is found in the nerve-centres of many of the lower invertebrates, as the Lumbricus; it is remarkably abundant in the *medulla*

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* Compare Meissner's plates of the brain of the Mermis, in Siebold and Kölliker's *Zeitschrift für Wissensch. Zoologie*, Band v. Plate xii. Fig. 13.

† *Neurology Untersuchungen*, &c., p. 157, *sqq.*

spinalis of the Amphioxus; it is also more present in the brain of the negro than of the white man. Its most uniform formation is in connection with the ganglionic expansion of the optic-nerve in all animals with eyes. Now, it is very certain that pigment-deposit in the brain and nervous system occurs in both acute and chronic diseases of the blood. In certain forms of ague and in some chronic diseases, the deposit blocks up the capillaries of the cell-layers and causes intense head-symptoms.* Of a like origin is probably the pigmentary retinitis observed by Graafe, Donders, and others, and which is characterised by pigment-deposit in the retina with obliteration of the blood-vessels.† In his experimental researches on the nerves, Dr Waller commonly found degeneration of the nerve-fibril to terminate in pigment-deposit,‡ and it is well known to be a common occurrence in the bodies of old persons. In certain forms of melancholia, there is probably pigment-deposit in the brain. But these pathological facts are out of relation with the physiological phenomena. Besides, difference of temperament, as indicated by the difference in complexion—*i.e.*, in pigment-deposit in the hair and skin—is a well-known fact of experience. It is probable, therefore, that the deposit has some relation, as I have already surmised (833), to the dynamical functions of the nervous system.

SECT. II.—*The Elementary Anatomy and General Functions of the Ganglionic Centres.*

881. Neurological research has been conducted with

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* Planer, *Zeitsch. d. Wiener Aertze*, (1854); Meckel, *Deutsche Clinik* (1850), No. 50; Virchow, *Archiv. für Physiol.*, Bd. v.

† *Ann. d'Oculistique*, tom. xli. pp. 21, 31.

‡ *Comptes Rendus*, tom. xxxiii. p. 608.

remarkable success during the last few years, owing to the discovery of improved methods of preparing and examining the tissues of the nervous system. It is too much, perhaps, to expect that microscopic neurotomy is thereby placed on a solid foundation; but it is certain that many errors have been corrected, and a beginning made for greater success than could have been even hoped for a few years ago. The tendency of the recent researches instituted by Stilling, Bidder, Kölliker, Robin, J. L. Clarke,* Lenhossék, Gerlach, Schr. V. der Kolk, and others, has been to establish the doctrine, that the ganglia and cerebro-spinal centres are made up of cells and plexuses of nerve fibrils, in definite relation to each other.

882. The ganglionic cells give off processes, as we have seen, which either join to each other (fig. 5) or are continuous with the axial cylinder of a nerve-fibril. In this way the motor nerves arise in the spinal cord from nerve-cells, and the sensitive nerves terminate in them. The cells differ, however, in different ganglia as to various points. Thus, in the sympathetic ganglia, in the anterior grey matter of the spinal-cord, in the brain, and in such a structure as the electric lobes of the torpedo, they occur in the greatest number; they are for the most part of a larger size; and are predominantly multipolar. On the contrary, in the intervertebral ganglia, and in the posterior grey matter of the spinal cord, they are comparatively fewer, of a smaller size, and in the ganglia predominantly bipolar. If general conclusions as to the characteristics of cells and the functions of tissue could be established, farther researches into the functions of the

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* I have had an opportunity of seeing some sections of the spinal cord prepared by Mr Clarke, according to his own peculiar method. and can testify to their great beauty and value.

complex portion of the nerve-centres, would be much facilitated.

883. There are, however, one or two general conclusions already reached, which it will be useful to note. In the spinal cord, nerve-cells are found in greatest numbers where the greatest number of nerves arise, or are inserted, thus showing their distinct functional relation to the latter. This has been established satisfactorily by Mr Clarke's researches,* which thus confirm what had been already inferred from the increase of grey matter in the spinal cord, where the nerves to the extremities are given off.

884. Another point established is, that under certain circumstances the cells are arranged in layers or strata. Gall was the first to say that the hemispheres were an extensive membrane of nerve-tissue. M. Baillarger showed, in 1840, that they consist of alternate layers of grey and white matter to the number of six, a white layer being the external surface. Gerlach, we have seen, shows there is a laminate arrangement of cells in the convolutions of the cerebellum. Rolando described the medullary matter of the spinal cord as an extensive surface folded up, and Cruvelhier considered it to be in laminæ. Now Mr J. L. Clarke, in his beautiful drawing of a transverse section of the posterior grey matter of the spinal cord, from the middle of the cervical enlargement of the ox, shows that this cell-stratification occurs there. The gelatinous substance is seen to have a stratum of large cells and marginal nerve-fibres along its posterior border next the posterior column.† The same arrangement of the cells is also seen in his drawings of sections of the gelatinous substance in the cervical and lumbar enlargements of the tortoise.‡

* *Phil Trans.* 1851, p. 614.

† *Phil. Trans.* 1859, Part. I., Plate 19.

‡ *Op. cit.* Plate 25, Fig. 44, 45, D.

Mr Clarke has also shown that the olivary bodies are folded strata or laminæ of multipolar nerve-cells.* This laminate arrangement is further indicated in Mr Clarke's drawing of the ganglia of the pharyngeal plexus of the earth-worm (see fig. 8), where a lamina of cells occurs at several junctions of branches of plexuses. This is so distinctly the arrangement in the hemispheres and convolutions, that it would be of some physiological interest to determine whether there is any functional difference in the cells that are arranged in laminæ, and those arranged in masses as nuclei.

885. The ganglia appear to be essentially plexuses of fine nerve-fibrils in connection with nerve-cells, which increase in complexity and extent according to the extent of living tissue with which the ganglion is in relation. Thus there is a direct relation between the number of cells and fibrils of a ganglionic mass and its functions. It may not, however, be in direct relation with nerves (as is the case with the sympathetic ganglia); on the contrary, the most important ganglionic masses, such as the convolutions of the cerebellum and cerebrum, are in relation with other ganglia. It seems possible to apply the law of evolution and differentiation of living structure in general to the development as well as the functions of the nervous system. Thus we have seen that the nerve-fibril may be an integration of nerve-cells. We can ascend from the former to the ganglionic motor-nerve, as the first rudiment of a ganglionic plexus, the one or two nerve-cells being the representatives of the ganglionic masses in the latter. Now, the mode of formation of the ganglionic plexuses of the sympathetic is well shown in a reduced drawing of the anatomy of the cephalic ganglia, and their connections, of the earth-worm, with which Mr

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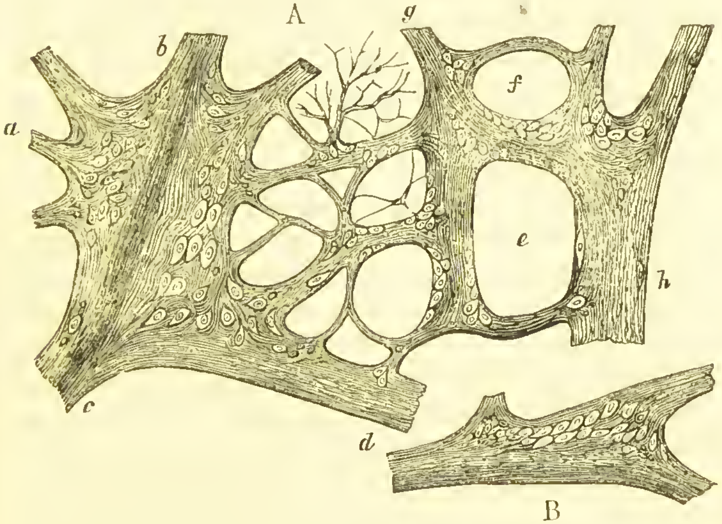
* *Phil. Trans.* 1858, Plate 15, Fig. 25.

J. Lockhart Clarke has favoured me. The original drawings are of a highly interesting character, and were made the subject of a communication to the Royal Society of London in December 1856, and noticed in its Journal of Proceedings for Jan. 1857.*

Fig. 8.



A, represents a small portion of the beginning of the gangliated pharyngeal plexus of the earth-worm, magnified about 180 diameters, and showing the grouping of the cells at particular parts of the branches. At *a*, some of the fibres of the three branches are derived from the angular group of cells, while others form loops with each other along the border. The *central* fibres of the branch *b* are seen to pass uninterruptedly through the ganglion to the opposite branch *c*, some of the fibres of which also take their origin from cells, while others are directly continuous with those of the branch *d*. In the same way the *central* fibres of the branch *g* are continuous between the vacant spaces (*e f*) with those of the branch *h*, along the borders of which some solitary cells may be seen. The fine dots indicate the nuclei on the primitive fibres.

B, represents a group of cells at the junction of four branches of the plexus. Each branch derives some of its fibres from the cells, and communicates with its neighbours.

886. In determining the functions of nerve-cells, as

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* This cut derives additional value from the fact that it was drawn and engraved under Mr Clarke's immediate supervision, who made fresh examinations to satisfy himself of its accuracy.

they exist in connected groups, we have to bear in mind what the nervous system is. According to the biological principles already developed, it is that structure which is especially the seat of the teleiotic ideas of the law of design; and especially that by which unity is effected in all the vital processes, and the ends of the existence of the organism attained. Its function is therefore a specialisation of that system of vital affinities whereby the transference of motion to ends is secured, and which are manifested in all living tissues whatever. The teleiotic properties inherent in all tissues will consequently be the special properties of the nervous system, and the ends attained by those are its functions.

887. As organisms are differentiated, organs adapted to the reception of affinitive impressions are evolved (470); in relation with these there are motor organs, and between them, and in affinity with both, is the nervous system—acting internuncially between the recipient and correlative motor apparatus. In its simplest form, the nervous system may be nothing more than co-ordinated cell-structures, in which the teleiotic energies of tissues in general are specialised. From *à priori* considerations, however, as well as from the largest observation, it is certain that such a co-ordinating apparatus becomes more necessary and more specialised in proportion as the archetypal idea is developed in a multitudinous series of relations of the organism; for in that proportion there must be a minutely developed differentiation and concurrent multiplicity of parts and functions, to be harmonised and co-ordinated to general results. This is well illustrated in the phenomena of visible motion in the higher animals, in which the direct application of stimuli to their highly complex system of muscles is not possible. Hence arises the need of an

apparatus of reception in the tegumentary covering—*i.e.*, an apparatus of discriminating touch. This, again, implies a conducting medium (an afferent nerve) by which the transeunt force can pass from the surface to the unifying centre—the group of nerve-cells; and this further requires a conducting medium (an efferent nerve) along which the transeunt force of the co-ordinating motor nerve-cells can pass to the muscle, or the group of muscles, to be co-ordinated (863).

888. This doctrine applies specially to visible motion; but it is not otherwise with those vital changes which, although invisible, also consist in motion, or the transference of force. Affinitive impressions being received by an afferent nerve, modify, through the co-ordinating ganglionic cells, that development of force out of the nutrient materials by which assimilation, growth, alimentation, and the like, are carried on, in accordance with the objects aimed at in the plan of the organism. Thus both growth (or invisible motion) and muscular action (or visible motion) are alike determined by external impressions acting on the ganglionic centres.*

889. Now, in examining our own states of consciousness, we find that a thought or a feeling precedes a voli-

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* Since one or two physiologists have recently brought forward this doctrine of reflex nutrition as a physiological discovery, and may therefore feel aggrieved if no reference is made to them, I will just venture to state in explanation, that it has been constantly expounded by me for many years past. Hence, in one of my letters to the late Mr George Combe, published fifteen years ago, I remarked: "I will now draw your attention to a new general law I have elaborated, . . . which will, I think, be of as great importance to natural history and physiology, as the law of reflex cerebral action to mental philosophy. This law I term *the law of reflex nutrition and development*," &c. (The *Lancet*, vol. i., 1845, p. 258.)

tion or act of motor energy; but we find, also, that the one may take place without the other either preceding or succeeding. Hence the conclusion that there are two distinct portions of the nervous centres for the two processes. Anatomical and physiological research has proved its entire accuracy. These have not been discovered in the sympathetic system; but the division of the cerebrospinal axis into two parts, the motor and sensory, is one of the best-established facts of physiology.

890. Referring then to the minute anatomy of the spinal cord for the laws of action of nerve-cells in groups, we find that the most recent researches only serve to develop more and more the doctrine that the ganglionic centres are a special machinery adapted to the purpose of combining vital processes into unity. The cells in the anterior grey matter are connected with one another by more or less ramified fibrils of communication, so as to form into distinct groups or nuclei (fig. 5.) From these cells arise also efferent (or motor) nerve-fibrils, which, combining into a cord, constitute the roots of the anterior or motor nerves, the fibrils of which pass not only into the muscles of the trunk and extremities, but also to the ganglia of the sympathetic. So that some of these fibrils are in fact commissural fibrils—*i.e.*, the medium of connection of ganglion with ganglion.

891. Of the nerves which go to muscles, the functions proper are various, as they serve to excite action of the flexors or extensors, pronators or supinators, &c. But the common function of all is to bring the innumerable muscular fibres which make up the group into action at one and the same moment—to unify, in short, their functional activity. Whether this is due to the co-ordinating influence of one nerve-cell—*i.e.*, whether there is a nerve-cell for every muscle—has not been inquired into.

Sch. V. der Kolk thinks there is; more probably, either the nerve itself, or the plexuses from which they come off immediately before they are distributed, is the co-ordinating mechanism. Nevertheless, these must be finally in relation with the spinal ganglionic cells. Hence, Sch. V. der Kolk likens a connected group of the latter to a battery of Leyden jars connected with one another, which can all be discharged at once through one conductor; and he further infers that there must be as many such groups as there are separate systems of muscles or movements in the body.*

892. But it would be a mistake to suppose that they supply the force needed to contract the muscles; that, we have seen, the muscle can supply for itself (846); they only send the stimulus for its co-ordinated production. Consequently, the greater the variety of movements of a set of muscles, the more numerous the cells in the group by which those muscles are co-ordinated. This is very well shown by the larger groups at the points where the motor nerves for the extremities are given off, and the muscles of which are exercised so variously (883). It is also shown by a comparison of the structure of the spinal cord in the sturgeon and the frog, by Sch. V. der Kolk, who found it of nearly the same thickness in the two animals, although the sturgeon weighed about 120 pounds, and its muscular system constituted by far the greater bulk of the animal. The same small cord is seen in the shark, plaice, pike, and other fishes. The reason why the small frog's *medulla* is so nearly equal to that of the large sturgeon, Sch. V. der Kolk believes to be, that it has in its springing motion a greater variety of movements to co-ordinate. This illustration is not, however, so cogent, in my opinion, as the other.

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* *On the Spinal Cord*, translation, p. 60.

893. But granting these doctrines, what leads to the discharge of the battery at the right time? The stimulus of the will is one means, sent directly downwards along the anterior columns to the anterior grey matter; as to another source, when automatic or involuntary movements are induced, the hypothesis of reflex efferent nerves is adopted by Wagner. These arise from the surface or periphery, enter the cord with the sensitive nerves, pass through the posterior grey matter to the anterior, and there unite with their respective groups of ganglionic cells; so that when an appropriate impression travels along this route of conduction, and arrives in the anterior grey matter, it discharges the appropriate battery. The objections to this hypothesis are many; one need only be mentioned. There appears to be no such direct communication through the grey matter as is here assumed between nerve-fibrils of the posterior roots and the anterior grey matter; on the contrary, all researches seem to agree in the conclusion, that the posterior fibrils either ascend longitudinally in the posterior columns, or else are united with the cells of the posterior grey matter; so that it is from these the stimulus is derived which fires the battery—that is, from the cells of the grey matter of the sensory tract. And this seems to accord with the origin of volitional stimulus from the brain-cells, which is not otherwise accounted for. We think to will, and do not; the seat of the thought is therefore distinct from that from which the dynamical stimulus orginates, otherwise every time we thought to will, the battery would be fired. In hemiplegia, the patient may will to move to the utmost, yet no motion follows.

894. But there is another point not explained, I think, by the able investigators I have named—namely, how it is that new groups of cells are formed in accordance with

the infinitely varied combinations of the muscles, in all those numerous instances on which skill in art-work, habitual movements, or even writing and speaking depend? Further, as the spinal cord influences the sympathetic through the motor roots, how are all the new adaptations of growth and development effected? Is this done by groups of cells?—Such are the great questions which lie behind these speculations.

895. Finally, to understand the true properties of these cells, we must bear in mind the important fact, that they are only specialisations—impersonations, so to speak—of the law of design. Hence, in considering them, we must remember of what the sperm-cell and germ-cell are capable when integrated, and give these nerve-cells credit for the same potencies. Nor must it be forgot, that, somehow or other, the tissues which produce these same two genetic cells, must be in such relation with the nervous system, that the cells which they evolve can, when brought into vital affinity, and a fertile ovum produced, constitute a vital substratum, out of which structures like these same nerve-cells and ganglia, with all their peculiar activities, will be produced; so that a child will smile, or frown, or grimace like his father, even although he never saw him in life.

CHAPTER III.

EVOLUTION OF THE NERVOUS SYSTEM IN DEVELOPMENT AND FUNCTION.

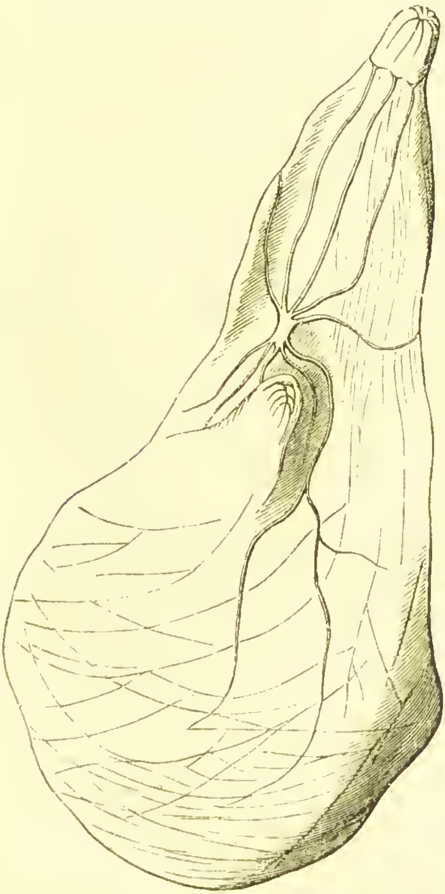
Sect. I.—*The Teleiotic or Primordial System—The Sympathetic.*

Having determined the elements of the nervous system, and having set forth the principles upon which the general and special homologies of form and function may be determined, we now proceed to determine what is the teleiotic or primordial form out of which all the subordinate and more special systems are evolved. The form and relations of these will follow the general laws of form and relation of organisms—*i.e.*, the fundamental law of the vital forces (246, 247, 302, 706, *sqq.*)

896. To obtain a clear conception of the fundamental form and functions of the nervous system in the simplest organisms, let us build up such an one according to the fundamental teleiotic homologies. If a *Hydra viridis* were to be endowed with a nervous system of the simplest kind, it would be a ganglionic motor nerve (885), running like a collar round the mouth, to co-ordinate the action of the tentacula; or a ganglionic group of connected motor nerve-cells, giving fibrils to them. If it were wished to make it more complex, then a stomato-gastric centre of ganglionic cells would be placed in the middle of its sac, which would co-ordinate all its functions of aëration, digestion, elimination, &c. (557), by means of internuncial

nerve-fibrils. If a higher degree of complexity were needed, then a special ganglion would be appropriated to the foot (a pedal ganglion) for locomotion; and another to the aërating apparatus—a branchial ganglion.

Fig. 9.



Ascidia Mammillata, showing the single ganglion between the branchial and anal orifices—the primordial type of a complete nervous system. (After Cuvier).

897. Now, such is the order of development of the nervous system in the acephalous Molluscs. In the Polyzoa, there is a solitary ganglion, situated on the outer surface of the œsophagus, which gives off branches to the tentacula and the lophophore or disc which supports them, and to the œsophagus itself.* In the *Phallusia intestinalis*, the single ganglion sends off one set of filaments, which surrounds the branchial orifice, and gives nerves to its tentacula. In the Ascidiæ, the solitary ganglion is situate on the muscular

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* Professor Allman. *On the Fresh-Water Polyzoa*, p. 31.

coat, between the anus and the branchial orifice, from which branches are sent to the œsophagus, which encompass it in the form of a ring. (Fig. 9.)

898. In the oyster, there is a posterior (double) ganglion added to the anterior ganglion; this co-ordinates the actions of the respiratory apparatus, and of the mantle and adductor muscles (of locomotion). In the limpet, a differentiation takes place; and the foot has a ganglion (the pedal ganglion) to itself. But the limpet has also eyes; it has therefore two ganglia to receive impressions from them and the tentacles, which are connected with each other, and with the branchial and pedal ganglia, by commissures. In the scallop (or *Pecten*), there is a pedal ganglion, but no optic ganglia; the œsophageal ganglia are connected with the pedal ganglia on the one hand, and the branchial on the other. Now, to call these simple structures, or any one of them, "brain," is to use a term without any meaning. The creatures have no heads, only a mouth and viscera contained within a contractile sac.

899. Eyes are not the essential characteristics of heads; in the Polyophthalmia they are in pairs on the body, down to the tail, the movements of which are directed as if it were a head. This multiplication of eyes is simply the result of a serial differentiation of the ectoderm or integumentary tissue (709). It is seen, therefore, in animals of the simplest organisation. Eyes are found in the Holothurias and vermiform Actiniæ about the tentacula; in several Tunicata, in which the eyes are near each orifice; in the mantle of the Spondyli, Tellinæ, Arcæ, &c.; in the lower forms of the Radiates, as the rotifers; in the star-fishes; nay, in a mere self-moving ovigerous organism (720). The organ of hearing is developed under the same circumstances as that of vision: in the Medusæ it is symmetrically multiplied along the margin

of the disc; in the Molluscs it is in the foot, in close relation with the pedal ganglion. The ganglia in connection with these organs are the teleiotic, not the structural, homologues of brain.

900. The eyes themselves are so well developed, that it obviously follows the co-ordinating ganglia must be highly developed too. M. Quatrefages enucleated the crystalline lens of a Syllis, and so arranged it in his microscope that he converted the instrument into a telescope, by which he could "distinguish with perfect clearness the very smallest details of the neighbouring coast."* And he adds, that he has found in the eyes situate in the mantle of the mollusc almost all the parts which are present in the eyes of a mammal, even to the eyelashes and eyebrows, which are represented by fleshy cirrhi. Now, these complete organs are evidently sentinel-organs, and therefore their ganglia direct the movements of the foot or the branchiæ, in reference to the external relations of the animal. They are optic lobes; and, according to the current but doubtful hypothesis of the function of the tubercula quadrigemina, must be considered the analogues of those structures.

901. If we turn to the viscera and visceral nerves, we find that the former, even in the plant-like sessile molluscs, are all highly differentiated as compared with those of a polyzoon. There is a distinct stomach and intestinal canal; highly developed glandular structures, as liver, salivary glands, and the like; a pulsating heart, ramifying vessels, and a distinct aërating organ;—yet every one supplied from the same single nervous centre, which has thus all the relations of the sympathetic system in man, with this difference that there is one ganglion only (usually double or bi-lobed), and not a series.

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* *Rambles of a Naturalist*, vol. ii. p. 180.

902. The same is true as to the non-striated or involuntary muscular system. The muscular structures which surround the orifices of the mantle are true sphincters, and have precisely the same relation to external things as the iris has to light, while the mantle or sac is homologous with the urinary bladder or glandular ducts in higher animals; for by the contraction of the sphincters, the entrance of inappropriate substances into the cavity of the mantle is obviated, and by the contraction of the sac its contents are expelled. These movements have been compared with coughing and sneezing in man, and may be so compared in so far as the general end aimed at is the same—namely, the expulsion of inappropriate things from a cavity. There is a teleiotic homology, but there is no true homology, or even analogy of form or structure, since in these organisms there is nothing whatever approaching to that complex apparatus whereby sneezing and coughing are effected, either as to the mechanism or the co-ordinating apparatus. The entire series of homologies are therefore both visceral and sympathetic, and not cerebro-spinal. Amongst the objections that may be raised against this view of the homologous character of the primary forms of a nervous system, I note one—viz., that in the nudibranchiate Gasteropods there is a true sympathetic system added to the "parieto-splachnic" of the lower mollusc, albeit it is not discoverable in the latter. This, I reply, can only be looked upon as a differentiation of the stomato-gastric system, arising coincidently with the greater complexity of the visceral differentiations.

903. The true homology of the sympathetic, as to the structures it co-ordinates, is to be found, therefore, in the one ganglion of these lower organisms. It is the first and most general form of a nervous system. Itself the

result of a specialisation of the co-ordinating vital forces inherent in all living tissue, it becomes, in its turn, that general system out of which all others are evolved, and of all which it is essentially the co-ordinating element. Hence it is that the sympathetic is in intimate relation with every portion of the cerebro-spinal centres, and with the organs of sense, as well as the viscera and skin. As these are evolved, it is evolved; as these are defective, those are wanting. So that if we wished to reduce man and his nervous system to the level of the sessile molluscs, we must deprive him of head, neck, and limbs; take away his thoracic and abdominal parietes, and vertebral column; put his viscera, lungs, and heart, into a contractile sac; and, finally, reduce his sympathetic system to the bi-lobed cœliac axis.

904. Now, this kind of change takes place conversely in the molluscs, as they are more and more differentiated, until the "acephalous" becomes "encephalous," and thence attain their highest type in the Cephalopods. In the highest of this class, we have perfect cephalic eyes and ears—*i.e.*, organs of hearing; an organ of smell, of taste, and of touch; a tongue, and well-formed jaws. The various ganglia are concentrated and integrated towards those situate on the anterior part of the body, and are surrounded by a sort of half-osseous cranium. Distinct ganglionic centres and nerves are evolved for the highly differentiated organs; so that the nervous system approaches to the type of that of a fish without the spinal cord. The one homogeneous ganglion is evolved into an integrated mass of nerve-centres, homologous with the *medulla oblongata* of vertebrates.

SECT. II.—*The Cerebro-spinal System.*

905. I selected the nervous system of the molluscs for comparison with that of man, because these animals are more individualized than the other invertebrata, which are, for the most part, composite organisms. Now, in man and the higher invertebrata, this individuality is reached not by a single ganglion, or by an integration of ganglia of special function, but by a co-ordination of many centres, each a repetition of the other. The highest type of this kind we have examined already, as communistic aggregations of individuals. (Part V. chap. viii.)

906. Those composite animals, we found, were made up of distinct organisms, termed Zoonites, each with their one complete heart and viscera, and feet; and their own one ganglion. In this respect, therefore, the zoonite is homologous with the lower tunicate molluscs, as a Polyzoon or Ascidian. But in each segment there is a pair of these zoonites, while in each tunicate there is only one. In the higher molluscs, however, it is different; two zoonites combine to form a gasteropod mollusc. And it is of importance to note, that, in these intermediate forms, the two zoonites conjoined in bilateral symmetry are male and female; or, in other words, a united couple. But then, again, these gasteropods differ in this respect from some of the annelids, for each segment of several leading forms of the latter is composed of five united couples (248, 718). We thus have bilateral symmetry and linear symmetry in these invertebrates. Such, also, is the law of the cerebro-spinal axis of vertebrates.

907. Now, if we would have clear conceptions of the morphology, laws of development, and functions of the cerebro-spinal axis, we must understand the laws of integration and differentiation of the ganglia of these

zoonites, in virtue of which an individual animal is constituted. These are two—1. Bilateral; 2. Polar.

908. *Bilateral Integration.*—In the oyster, scallop, and limpet, the bilateral œsopagheal ganglia are distinct, and connected by transverse commissures, from which stomato-gastric nerves are given off; while a co-ordinating collar surrounds the œsophagus, as the commissure of the two halves, and is thus the homologue of a cerebral centre. The branchiæ, however, are conjoined also, and therewith the two branchial ganglia are integrated into one central ganglion, which is in connection by commissures with the œsophageal ganglia and collar. These constitute the respiratory system. In the *Pecten*, the pedal ganglion is integrated in the same way; but in the limpet there are two distinct branchial and two pedal ganglia, each pair being united by a commissure to each other, and by a commissure to the ganglia on their own side. Thus, there are three modes of combination of ganglia:—1. Absolute integration, all identity being lost in the formation of one lobe; 2. Union by transverse commissures of the two symmetrical ganglia; 3. Union by longitudinal commissures of the different ganglionic centres of the same kind. Now, this is precisely what occurs throughout the brain and spinal cord of man and the vertebrates, and is also what occurs in the ganglionic chain of the invertebrates, in which each zoonite has its respective ganglion.

909. The *absolute integration*, whether transversely or longitudinally, is more and more marked as the animal advances from the earlier stages of development, or as the organism is higher in the scale of differentiation. Thus, in the *Timarcha tenebricosa* (a coleopterous insect), the supra-œsophageal ganglia are distinct in the larva-stage of development, but in the pupa-state they have

coalesced. In this way the transitory form of development corresponds to the permanent form in the less differentiated invertebrates.

Fig. 10.

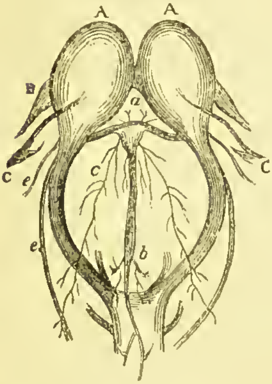
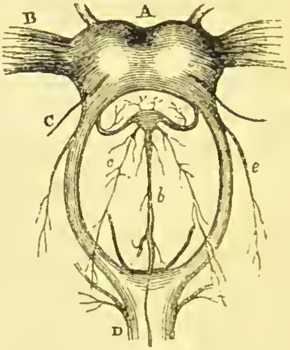


Fig. 11.



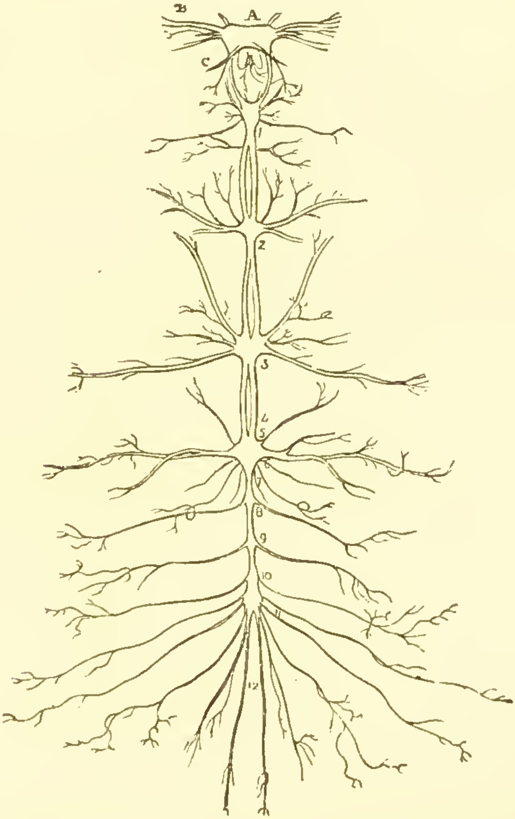
Description.—Fig. 10. Supra-œsophageal ganglia of the larva of *Timarcha T.* Fig. 11, the same of the perfect insect. Fig. 10. A, A, Supra-œsophageal ganglia; B, optic nerves; C, origin of the sympathetic and the crura; D, the *medulla oblongata; b*, the vagus or visceral nerves in connection with its ganglion; *e*, lateral nerves from the œsophageal ganglia. Fig. 11. A, Supra-œsophageal ganglia integrated.

910. It is in this way that the serial chain of ganglia varies so much in complexity in the Articulata. Just as in the higher Vertebrata the transitory forms which the nervous system assumes during embryological development correspond to the permanent forms of the lower, so it is with the Articulata. In the Myriapods and Annelids, each ganglion of each pair of ganglia is distinct from the other, and each pair from the other pair: they are connected only by longitudinal and transverse commissures or nerve-fibrils; while the anterior or cephalic ganglia, and its conjoined centres of systems, send off commissures which unite each ganglion to the brain. Thus there are three sets of longitudinal commissures, one between the ganglion above and the ganglion below; a

second between the cephalic ganglion, through the *medulla oblongata* D (figs. 10 and 11) and every other ganglion; and a third (*b*) between the respiratory or stomato-gastric ganglion and each ganglion.

911. Now, these serial ganglia, and their commissures, vary greatly as to the extent of integration. In the *Talitrus* they all remain distinct, so that the nervous

Fig. 12.



Nervous system of the perfect *Timarcha Teneb.*, showing the integrated and unintegrated longitudinal commissures.

system has the appearance of two parallel cords upon which there are symmetrically-disposed knots. In other more highly developed forms the ganglia may be integrated; the longitudinal cords partly integrated, partly not. This is what is seen in the *Timarcha* (fig. 11), in which the lateral longitudinal cords extending between the ganglia Nos. 1, 2, 3, 4, 5, are not integrated, while those between 4, 5, 6, 7, 8, 9, 10, are, forming one solid cord.

912. *Polar Integration.*—To ask why an animal has a head, must seem, to the reader who takes familiar things for granted, a wholly useless question. Yet it is one of the most important in morphology; for the same law by which a head arises at all ought to govern all the varieties of form which the head assumes. To know the reason why, is therefore to attain to a knowledge of a law which must be the foundation of all ethnological and physiognomical science. It is sometimes difficult to say which is the anterior extremity or head of an organism and which the posterior extremity or tail. It we look, however, to the ends aimed at, we shall see that the posterior extremity subserves to the processes of sanguification, fertilisation, and reproduction; the anterior to alimentation, often to aëration.

913. The same idea which leads to the development of social organisms (Part V. chap. viii.) guides the linear arrangement of the nerve-centres in the Articulata and Vertebrata. The first instinct of all organisms being to seek after nutrient materials, the first differentiation of structures is in fulfilment of this instinctive energy. Hence, the direction in which an organism *grows* is the direction in which its aliment is found. Thus, the mouth and tentacula of polypes grow towards the water which contains their food just as the roots of plants. This is the fundamental law of development and differentiation towards the anterior or food-seeking extremity of

animals. But this seeking of food is also the first and most primordial of the relative appetites and instincts, more especially of those varied kinds, whether egotistic or social, upon which alimentation depends. Hence, not only organs of the appetite are developed anteriorly, but also organs for seizing, holding, tearing, and crushing things suitable for food (627, 628).

914. This principle of morphology is perhaps that which will best serve to distinguish a plant from an animal. Roots are mouths, but they do not integrate; on the contrary, they continually divide. It is the posterior extremity of the plant which arises, and its aërating and reproductive organs which differentiate and integrate into the air. The posterior differentiation and integration of animals necessarily follows the same law as is manifested in the growth of plants. A receptacle for food must necessarily be formed behind the prehensive organ; and then, behind that, all those viscera by which digestion, chylification, and defecation are carried on, and which are abdominal, or hid in the trunk.

915. Nor are the reproductive organs exempt from the general law. It is only from the tissues behind the organs of alimentary prehension that the genetic cells can be developed. Hence, in the Articulata, the ovaria and testes are for the most part situate posteriorly, or multiplied posteriorly, as in the Tænia, the Nemertes, Syllis, &c., already mentioned (714, 717, 720). The law, like all general laws, is of the simplest. It is nothing more than a manifestation of a sequence in space such as occurs in time. Growth and development of the individual must necessarily precede the reproduction of the species; and as alimentation is necessary to the former, the organs necessary thereto must necessarily be developed anteriorly to the latter.

916. The polar integration of the nerve-centres in the Articulata has been demonstrated by various observers. M. Serres developed the doctrine both inductively and philosophically in his researches into the comparative anatomy of the nervous system. He showed that there are two centres of coalescence, one anterior and one posterior. Anteriorly, the integration always commences with the ganglia which are situate behind and before the œsophagus; first they are in simple union (see fig. 10, A, A); then they coalesce intimately, a raphe marking the line of junction. Then this raphe disappears, and the integrated ganglia constitute a homogeneous ganglion (fig. 11, A). After these the terminal pair of ganglia situate posteriorly coalesce after the same manner as the anterior (fig. 11, Ganglion); next the ganglia situate intermediately in the chain. The commissural fibres connecting the successive parts of ganglia integrate in like manner with different degrees of completeness, and as to different nerves, in various classes of the Articulata (fig. 12). It is by this integration of the lower nerves, and the development of the internuncial nerves extending from the coalesced anterior ganglia downwards, that the œsophageal ring is formed—the œsophagus interposing between the lateral strands, and preventing their coalescence. M. Serres has developed his views at length and applied them to the anatomy of the nervous system of the Articulata in his great work.* It is in the cephalic ganglia that that differentiation of structure with increase of size corresponding to the manifestation of those special instincts or modes of Energy, is so strikingly developed in the highest of the Articulata, the social Hymenoptera (723).

917. The same law of evolution and differentiation of

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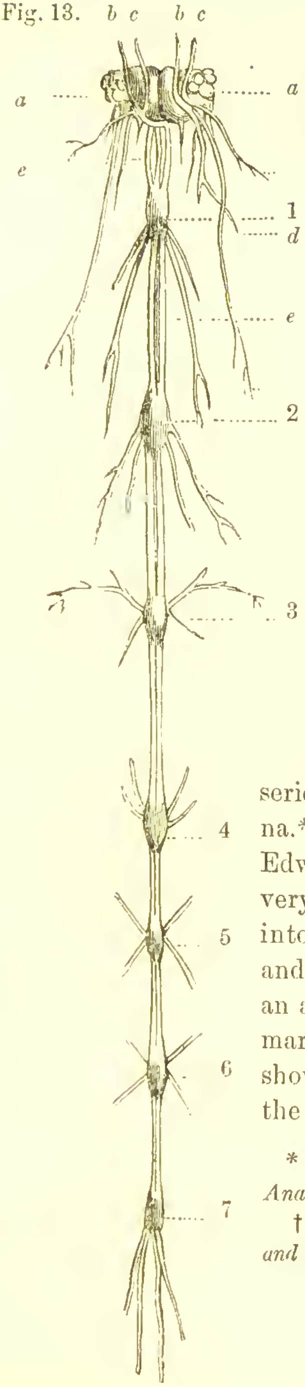
* *Anatom. Comparé du Cerveau* (Paris, 1824), tom. ii. pp. 15, *sqq.*

Fig. 13.



the ganglia at the oral extremity, is equally manifested throughout the Vertebrata, beginning with the Amphioxus, and ascending and expanding its operations until it attains its highest manifestations in the human encephalon. The particular modes of evolution and integration of the co-ordinating ganglia in the Articulata have been well shown by Mr Newport in his researches into the development of the nervous system of the Timarcha, Sphinx Ligustri, Vanessa, Urtica, &c., and may be consulted by the reader who wishes to know the details of this most remarkable series of developmental phenomena.* MM. Audouin and Milne Edwards have also illustrated it very admirably in their researches into the anatomy of the Crustacea, and of these M. Edwards has given an acceptable and interesting summary.† M. Audouin has also shown the operation of the law in the Arachnida. In the Scorpionidæ (fig. 13), the first or cephalic ganglion, *a a*, which supplies nerves, *b c*, to the structures of the mouth, is intimately blended with the ganglia which give origin to the nerves of the legs, *d*. The succeeding ganglia are seven : 1, 2, 3, are abdominal, and have this peculiarity, that they are united with each other and with the cephalic (or cerebro-thoracic) ganglion by three cords of communication, instead of the two which are found in all other Articulates. The four remaining ganglia belong to the *post-abdomen* or tail.

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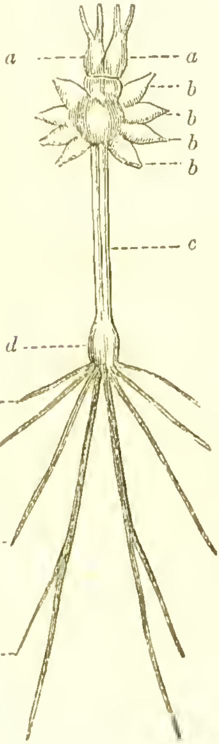
* *Phil. Trans.* 1832-1834, and *Cycl. of Anat. and Phys.*, Art. "Insecta," vol. ii.

† Art. "Crustacea," *Cyclop. of Anat. and Phys.*, vol. i. p. 762.

Fig. 14.



918. The operation of the law is still more strikingly shown in the spiders. The first pair of ganglia—the cephalic (fig. 14, *a*)—is quite distinct from the thoracic; these are four in number (*b b*), but have undergone a remarkable degree of centralisation, being intimately connected together, so as to form a mass in which all traces of junction are lost, except at the sides which have remained free, and are in the form of small conoid bodies directed outwardly, so as to resemble in the aggregate the figure of a star. From the apex of each of these small cones a nerve is given off to each leg. In the abdomen there does not exist any ganglion, but only a double longitudinal nervous cord (*c*) which swells out at its termination (*d*). From this ganglionic enlargement a great number of nerves pass off, which

are distributed to all the organs contained in the abdominal cavity.*

919. In man, this law of polar development has been little noticed; the bilateral symmetry having attracted attention almost exclusively. It is shown, however, very strikingly in the pathological phenomena of woman, in consequence of the mode in which, in her, nutrition is afforded to the ovum in utero, after fertilization (644). The greater size of the female pelvis is also due to this teleiotic law, inasmuch as it is necessary to provide for the development of the fœtus in utero. And it cannot be doubted, so numerous are the facts which indicate a special co-ordination of distant organs, that an arrangement of cells will be found in the lumbar region of woman and other mammals, in special relation, as a ganglionic centre, to the reproductive organs.† This centre will be found, in addition to another centre whereby the sexual organs are brought into relation with the great encephalic centres, and especially with that which impresses upon the germ-cell and sperm-cell the vital affinities and potentialities of the entire organism.

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* M. Victor Audouin. *Cyclop. Anat. and Phys.*, article "Arachnida," vol. i. p. 207.

† In a chapter of my *Treatise on the Nervous Diseases of Women*, entitled, "The Relation of Nervous Diseases to the Extremities of the Spinal Cord" (p. 197), I showed some of the pathological relations of this doctrine of antero-posterior development. Although almost wholly rejected, as Cabanis states, by the "modern mechanicians, because it does not appear to be supported by anatomy" (*Rapports du Phys. et du Moral de l'Homme*, 3me edit. (1815), vol. ii. p. 411), it had currency amongst the older physiologists, like other doctrines founded on observations of function now neglected.

CHAPTER IV.

ON THE FUNCTIONS OF THE SYMPATHETIC AND INTERVERTEBRAL SYSTEMS.

The functions of these ganglionic systems were confessedly unknown ten years ago. Numerous researches have been made during the interval, and with good results. I shall endeavour to generalize ascertained facts under the guidance of the principles developed in the last chapter, with the hope of advancing our knowledge a step further, and placing this part of the physiology of the nervous system on a more solid basis.

Sect. I.—*The Sympathetic System.*

920. The sympathetic system is made up of a series of connected ganglia, united by commissures of three kinds—plexiform, ganglionic, and cord-like. The ganglia may be classed as primary and secondary. The *primary* extend symmetrically in linear series from the neck downwards, lying on each side the spinal column as far as the lower end of the sacrum, where the two terminal ganglia of each side are integrated into one ganglion or plexus, situate on the middle line, in front of the coccyx, as in fig. 14, *d*. The ganglia in each chain correspond to the number of the vertebræ, except in the neck, where they appear to be integrated into the three cervical ganglia. From the superior cervical gan-

glion, a commissural cord passes off to enter the cranium, and bring it into communication by several branches with several small ganglia situate therein. Transverse ganglionic commissures, in the form of plexuses, unite this bilateral series of ganglia along its course. The principal, and probably a central commissure, is that which surrounds the cœliac axis. It is constituted of the two semi-lunar ganglia and numerous nerve-fibrils. Numerous nerves of communication pass also between the sympathetic and the spinal nerves (fig. 2, p. 348). It is thus, by its commissures, rendered a complete system in itself, and is also made a part of the more general system through the spinal cord.

921. The *secondary* ganglia of the sympathetic do not appear to be either symmetrical or definite in number. Some are found in the substance of the viscera; others in the various plexuses which are formed by the sympathetic. These are probably homologous with the groups of cells in the spinal cord, which are supposed to co-ordinate a muscle or sets of muscles (891). A similar formation of ganglia is seen in the pharyngeal plexus of the earth-worm, discovered by Mr J. Lockhart Clarke (fig. 8). Mr Clarke informs me that it is almost like a diffused ganglion of the higher animals, and provides for a most extraordinary, intimate, and varied communication between separate parts; even between single fibres, through the medium of single cells. He thinks it is subservient to the varied and consecutive movements of the different parts of the pharynx in its vermicular action, and, as it extends along the intestine (it is stomato-gastric), probably influences the contractions of the tube. The several minute ganglia found by Dr Robert Lee on the uterus and heart,* and by

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* *Engravings of the Ganglia and Nerves of the Uterus and Heart.* Lond. 1858.

Dr Beck on the plexiform arrangement of the sympathetic nerves around the uterine vessels,* probably serve the same motor purpose in the movements of the heart and uterus. Such a differentiation of the ganglionic system is seen also in the ganglia developed on the arms of the cuttle-fish, as observed by Dr Sharpey, and the function of which is clearly motor.

922. The most varied opinions have been entertained as to the homologies of the leading parts of the nervous system in man. Scarpa, Blumenbach, Cuvier, Meckel, and Gall, were the first to maintain the hypothesis that the ganglionic cord of the Articulata is the homologue of the cerebro-spinal axis in the Vertebrata; a theory so universally accepted now, that few physiologists seem to think it necessary even to doubt it, although it will probably be found untenable. Reil, Ackermann, and Bichat, were of opinion that the ganglionic axis of the Invertebrata corresponded to the sympathetic system of the Vertebrata. Reil founded his opinion on the fact that the sympathetic or ganglionic system proper is wanting in some animals, and in others is intimately combined with the cerebro-spinal system. He deduced from a consideration of the functions of the central axis in the Vermes, that it was the sympathetic of the higher animals arranged in a peculiar manner.†

923. A more generally received opinion is that of Weber, who maintained that the intervertebral ganglia on the posterior roots are the homologues of the axis of the Articulata.‡ It was adopted by Ampére and Serres, who held, however, more particularly, that the Gasserian ganglia are the homologues of the cephalic ganglia, and there-

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* "On the Nerves of the Uterus," *Phil. Trans.* 1846.

† Reil und Autenreith's *Archiv.*, Band vii. p. 190.

‡ *Anat. Comp. Nervi Sympath.* (1815), p. 95.

fore the seat of the instincts in Vertebrata.[*] Zinn, Carus, Jacobson, Weber, and Treviranus, also hold that the cephalic nerves of insects and crustacea are homologues of the nerves from the Gasserian ganglia. Meckel, Weber, Müller, Dugès, and Leuret, are of opinion that the chain in the articulates is homologous with both the sympathetic and cerebro-spinal systems. The present opinions have resulted from a sort of compromise. The sympathetic has been set aside, and the articulate axis taken as the simple homologue of the vertebrate. This conclusion is mainly due to the development of the reflex doctrines of Dr M. Hall; for reflex phenomena are very striking in the Articulata—a fact due, however, as we have seen, to their composite character. (Part V. chap. viii.)

924. The principal source of the differences of opinion upon these points is in the neglect of the teleiotic unity of structure and function, and the too exclusive reliance upon form. As to their linear and bilateral symmetry, the articulate and vertebrate axes are obviously homologous; but then there are three such symmetrical systems in man, and hence the character fails to serve its purpose. But, more important still, it excludes the central axis of the Radiates and Molluscs altogether. And when we remember that each single ganglion in the series, with its branches, represents in Radiates, the Annelids and hermaphroditæ Gasteropods, an entire nervous system, even to the optic nerves (899), it is equally obvious that it excludes them from consideration also.

925. Now, in accordance with the doctrines laid down, the sympathetic is the homologue of the primary form of the nervous system. It is that which is nearest to the

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[*] Ampère, "Considerations Philos., &c.," *Ann. des Sc. Naturelles*, tom. ii. p. 295, and tom. iii. p. 202. Serres, *Anatom. Comp. du Système Nerv.*, tom. ii. chap. i.

tissues themselves. As to function, it is homologous with the nervous system of the Radiata and Molluscs; as to form, it is homologous with none. Its ideal homologue would be constituted by a serial integration of the ganglia of the latter.

926. The sympathetic is therefore in immediate relation with the vital forces of all the tissues, either directly, by continuity with the tissues, or through its influence on the distribution of the blood, over which it presides generally. It is consequently the most universally diffused system, being everywhere. Hence, we find that it is called into action on the most widely different occasions. Thus, while all the changes of mere visceral life are carried on by it without any consciousness on our part (45), its operations are associated with our strongest feelings, whether they be appetites or passions. The tears of sorrow are due to the same *vis nervosa* as the simplest secretion, and every stroke of the heart in emotion occurs under the same influence which secretes bile.

927. We may conclude, indeed, from all its various phenomena, that the sympathetic system is as much a channel by which transference of force is directed by the encephalic ganglia as the anterior grey matter of the spinal cord. And there is at least one case on record—that of Colonel Townsend—in which the will could act on the heart; while a gentleman still living can dilate or contract his iris at pleasure. Now, the movements of the latter structure, at least, are certainly due to the motor influence of the sympathetic. It is hardly necessary to revert to the experiments of Petit, Magendie, Volkmann, Flourens, Longet, Budge and Waller, Claude Bernard, and Brown-Séquard, and others, as all in accord upon this point. The sympathetic is fundamentally a motor system. Although not necessarily associated with in-

voluntary movements, the changes to which it gives rise are for the most part both involuntary and unconscious.

Sect. II.—*The Intervertebral System.*

928. The intervertebral system is a connected chain of ganglia, situate within the vertebral column. It is in the same anatomical relation to the contents of the cranio-spinal cavity, as the sympathetic to the contents of the visceral cavity. It is, in short, the sympathetic of the cerebro-spinal centres, but more especially, probably, of the sensory portion, or that which has the office of adapting teleorganic changes to new external conditions (323).

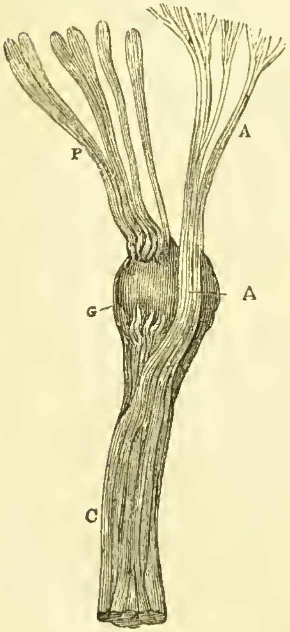
There are thirty-one pairs of spinal ganglia in all; eight in the cervical region (including the sub-occipital), twelve in the dorsal, five in the lumbar, six in the sacral. But since Sir Charles Bell determined the true functions of the 5th and 7th cerebral nerves, the trigeminal ganglion is to be classed with the intervertebral ganglia. The ganglia on the roots of the vagus and glosso-pharyngeal nerves belong also to the system; for although they are differentiations of the sympathetic system, they are in intimate relation with the *medulla oblongata*, which is a centre of all the systems.

929. Each ganglion is situate within the bony case of the cerebro-spinal axis, except the last just mentioned. Each root of the spinal nerve passes out through a distinct opening in the *dura mater*. Immediately external to the *dura mater*, the ganglion appears on the posterior root of a size proportionate to it. The anterior root lies embedded on the anterior surface of tho ganglion, and involved in the same sheath, but without mingling its fibres with those of the ganglion. Beyond it, the nervous

fibres of both roots intermingle, and a compound spinal nerve results.

930. This ganglionic system seems at first sight to be a mere series of isolated ganglia; but this is by no means the case. The spinal cord is itself a continuous column of ganglionic matter, so that the bundles of fibres situate between it and the spinal ganglia (fig. 15, P) are transverse commissures. They are not roots of a nerve at all, in the same sense as the term is applied to the anterior bundle of fibres. If we use the law of bilateral linear organisation and development to determine their functions, we may conclude that these transverse commissures must not only serve to unite the ganglia to the posterior grey matter, but that fibrils must continue onwards through the cord to combine with the fibrils of the opposite ganglion. There should therefore be decussating sensory fibrils in the spinal cord; and this appears to be established as well by anatomical research,* as by the experimental researches of Van Deen, Dr Brown-Séquard, Schiff, and others. According to the same law of development, the ganglia of the same side must be united

Fig. 15.



Cords of attachment of a spinal nerve. (After Bell). A, A, Anterior root; P, posterior root; G, ganglion; C, compound nerve.

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* Stilling, *Untersuchung: ü. die Textur des Ruckenmarks.* J. L. Clarke, "Structure of the Spinal Cord," *Phil. Trans.* 1851, p. 16. Sch. Van der Kolk, *On the Spinal Cord*, ed. cit. p. 4.

by longitudinal commissural fibrils. Upon this point the anatomical evidence tends to the affirmative; the physiological is decisive. It must be remembered, however, that these longitudinal and transverse commissures are probably integrated as to the five ganglia which are in relation with each of the limbs, inasmuch as five segments of the cord itself are integrated to constitute the corresponding kinetic substrata of the four extremities.

931. The functions of the intervertebral system have been investigated experimentally by Bell, Mayo, Magendie, and others; and pathologically, by Serres, Romberg,* and numerous physicians. Before proceeding to inquire into the results of these investigations, it will be well to determine specifically the structures with which it is in peripheral relation. These are, first, the viscera and the internal surface, supplied by the sympathetic; secondly, the skin. Now, the skin is the seat of two kinds of sensibility: first, parts of it are constituted into an organ of touch; secondly, it has common sensibility. As to the latter, there is a special property of the nerve-expansion to be noted. It is found that the sensitive nerve which enters the ganglion from the skin corresponds to the muscles below; or, to use Sch. V. der Kolk's words, who seems to be the first to have demonstrated the fact, "a spinal nerve gives its motor branches to the muscles as instruments of motion, and its sensitive branches to the part moved." Thus, if the palm of a child's hand be tickled, the flexors act; if the back of the hand, the extensors contract; in the one case it is the median nerve, in the other the musculo-spinal, which supplies the skin and the muscles below.

932. The nerves of touch as well as of common sen-

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* *A Manual of the Nervous Diseases of Man* (Dr Sieveking's Translation for Sydenham Society), vol. i. chap. xx.

sation, pass through these ganglia, and the muscles of the fingers are used in the same way as of the eye or ears in forming an organ of touch. But we have seen that both these organs are developed out of the integument or ectoderm in the lower Radiata and Mollusca, and eyes in the Polyophthalmia and Syllis. If we apply this law of development to the skin of the face and head in man, we must conclude that the sensory fibres of the 5th are not only in relation with the facial muscles and their nerves, but also with the nerves of hearing, vision, and smell, and their muscular apparatus. We might even go further, and conclude that these three have their relations to particular groups of nerve-cells in the three-lobed Gasserian ganglion.

933. Besides these special relations, the skin, as the evolution of the ectoderm, has its own vital properties. It is the point where changes of temperature are felt, and probably has nerves expressly adapted to the cognisance of them (758). It has nerves (reflex) in relation with muscular adaptations for defence; and embedded in its substance are numerous glands endowed with very different functions, as mammæ, sebaceous glands, hair-follicles, each having special relations to other glands, but especially the urinary and generative.

934. The intimate relation between the intervertebral system and the skin are best illustrated by those phenomena which result from injury, removal, or structural disease of the Gasserian ganglia, to which the nerves of the skin of the face and the surface of the eyes, ears, nostrils, lips, are attached. Magendie showed experimentally, in 1824, that the influence which these ganglia exert upon the vegetative processes of these surfaces and organs was great. After dividing the nerve at a point between the ganglion and the surface, or after destroying

the ganglion, he found that the conjunctiva and iris on the same side became injected, plastic deposit took place on the anterior surface of the latter, the cornea became opaque, and the eye finally ulcerated. In the nostrils and mouth, analogous results were observed. The mucous membrane of the nose reddened, and discharged mucus; the gums ulcerated, and left the teeth.* Abundant confirmation of these experiments has been given of late years by M. Claude Bernard, Dr Brown-Sequard, M. Schiff, and others. Hence, while section or injury of the sensory branches of the 5th is necessarily followed by anæsthesia, important changes in the vital properties of the tissues supplied from the ganglion also result.

935. Now it does not seem certain that the afferent nerves of the skin in connection with the ganglia are the immediate cause of the nutrient and vascular changes proper to the cutaneous tissues, any more than they are the cause of visible motions. They are only the channel by which external affinitive impressions (considered as definite transeunt forces) pass along to the ganglion, there to be deflected upon the sympathetic nerves; or else to pass on to the posterior grey matter of the cord, there to be reflected upon the motor nerves. Consequently the series of teleorganic changes *begin* at the skin, but they have to pass through the ganglionic centres before they *end* on the skin. If, therefore, there is anæsthesia from disease of the peripheral fibrils only, there will be no change received, and consequently none transmitted; and as a result of that, no ganglionic function excited, and no nutrient activity through the sympathetic. It may be concluded, indeed, that there is a differentiation in the sympathetic system itself into

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* M. Magendie. *Journal de Physiol. Exper. et du Pathol.*, April, 1824, p. 176.

afferent or excito-nutrient nerves and reflex motor, just as there is a differentiation of the nerves of touch into an auditory and optic nerve, and of the tissues of the skin into the apparatus constituting an ear and eye.

936. Numerous facts are in accordance with these doctrines. For example, if the ganglion be left untouched, but its commissural connection with the spinal cord be cut off, there will be anæsthesia, but not degeneration and cessation of nutrition of the cutaneous tissues. Thus, Magendie found, in 1824, that if the root of the 5th was cut between the *medulla oblongata* and the Gasserian ganglion, the changes in the nutrition of the parts supplied by the 5th advanced much more slowly than when the nerve was cut on the peripheral side of the ganglion, and its connection with the tissues was severed. M. C. Bernard, in confirmation of these observations of Magendie, states that when he has divided the sensory root of the 5th in the brain itself ("*dans le cerveau même*") at a point sufficiently distant from the ganglion, the changes in nutrition have not occurred at all—only anæsthesia and its concomitant phenomena; and this, he says, is in accordance with all that we know of the influence of the intervertebral ganglia on the nutrition of nerves, and with the results of pathological observation.*

937. On the other hand, the influence of anæsthesia from disease, commencing at the afferent periphery, upon the nutrition of the skin and other tissues, by cutting off the excito-nutrient stimulus of the sympathetic, is proved by the phenomena of Norwegian leprosy. Danielsen and Böeck show that in that form (the anæsthetic) in which cutaneous sensibility is lost, there is disease of the spinal cord, limited to the posterior portion, in which the grey matter is entirely altered and yellow, and exudation

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* *Leçons sur la Systême Nerveux*, &c., tom. ii. p. 61.

takes place, occupying extensive regions of the cord, and generally spreading partially to the posterior roots of the spinal nerves. In these cases, the skin, &c., undergoes important changes, very like those associated with disease of the Gasserian ganglion. The conjunctivæ are injected, the cornea is opaque, the septum of the nose is ulcerated; all cutaneous transpiration is arrested; the hands waste, and are low in temperature, often only 68°. Finally, ulceration and necrosis take place. When the face is affected, as it usually is, the Gasserian ganglia are found diseased.

938. It would seem most probable, at first sight, that the morbid changes in this class of cases began centrically, and not peripherally; but that is not the order of the phenomena. Leprosy is a disease of the skin. Now, in these cases, while hyperæsthesia precedes the anæsthesia, successive eruptions of bullæ, inflammations, and other morbid conditions of the skin, precede for many years the hyperæsthesia; so that these cannot be due to centric disease. Besides, it is found that the cutaneous nerves of those who have suffered from necrosis and gangrene are much tumified, and their sheaths filled with a firm albuminous deposit.

939. Further, Dr Waller's experimental researches show that the morbid changes in the nerves take place in the same direction that the transeunt force passes. Thus, if the sensory nerve be divided on the peripheral side of the intervertebral ganglion, no change takes place in it; if on the other side, then the part attached to the ganglion is unchanged, while that in connection with the spinal cord is disorganised. Again, when the anterior root is divided, the nerve-fibrils are disorganised even to the muscles on the peripheral side; but the end attached to the cord is unaffected.*

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* Compare Dr Waller's Researches, *Comptes Rendus*, tom. xxxiv.

940. M. Claude Bernard has fully confirmed these experiments of Dr Waller, but he does not find that removal of the intervertebral ganglia is followed by such marked changes in the nutrition of the tissues as was seen in the experiments of M. Magendie on the Gasserian ganglion. Yet he remarks, that a dog having had the posterior roots of the nerves going to a limb divided, the limb swelled, and gangrenous inflammation appeared in one spot, and also at the end of the tail; but generally these results have not followed, even when the intervertebral ganglion has been removed. This may, however, be accounted for by the integration of the commissural connections of the ganglia in the spinal cord (930). It is quite probable that a certain amount of motor nutrient stimulus may reach a limb by another channel in cases of this kind.*

941. There are some remarkable cases of symmetrical cutaneous diseases which may be explained according to this doctrine of the functions of the intervertebral ganglia. Such, for example, as cutaneous hemiplegia, in which there is a difference of colour on the two halves of the body, from half the nose downwards; cases of ague, limited to one half; also cases of rubeola, or of chronic cutaneous disease of one side; as, for example, that of a merchant, who had congenital ichthyosis of exactly the right half of the body, and extending even to half the penis, including the glans.† There are cases, too, of imperfect lateral development, as of half the face, and even of exactly half the body, of which Dr Paul Brocca has recently recorded an instance.‡ In short, the causation of a multitude of hitherto inexplicable phenomena may be thus comprehended.

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* Some experiments of Schiff tend to prove this opinion.

† *Amer. Jour. of Med. Sciences*, Jan. 1852.

‡ In Dr B.-Séquard's *Jour. de la Physiol.*, *&c.*, No. V., Jan. 1859.

SECT. III.—*Reciprocal Relations of the Sympathetic, Intervertebral, and Spinal Ganglionic Centres.*

942. It is well known that changes in the spinal cord itself influence the functions of the sympathetic; it is also probable that changes in the intervertebral ganglia will influence the nutrition not only of their interspinal commissures (the posterior root), but also their continuation and connections in the posterior grey matter of the spinal cord itself. We have now to inquire into the reciprocal functional relations of these structures.

943. According to the fundamental laws of development, the co-ordinating apparatus of the spinal cord must be looked upon as a differentiation and specialisation of the sympathetic and intervertebral systems. On the one hand it has a function in relation to them; on the other, to the encephalic ganglia and the special differentiations in the *medulla oblongata*. Now, like other centres, it presents the two great divisions of structure; one endowed with the function of adapting, the other with the function of exciting the transference of force in accordance with the adaptation. The one is homologous with the region of the ideagenic substrata in the hemispheres, the other with the region of the kinetic (325, 326).

944. Now, in the idea of motion are included the chemical changes which accompany growth, the production of animal heat, and the movement of the blood in the blood-vessels, as well as the phenomena of muscular motion proper (Part V. chap. v.); so that the action of the vaso-motor nerves, the production of animal heat, and secretion and excretion, are all regulated by the kinetic substrata of the spinal cord. Or, in more general terms, as motion is only another name for the transference of force, the kinetic substrata will also exercise an

influence upon the production of animal heat and the other mechanico-chemical forces. Hence we can distinguish the following motor centres:—1. That of the voluntary system of muscles. 2. That of the involuntary. 3. That of the vaso-motor system, which has two relations to the blood and blood-vessels—namely, *first*, as to the production of motor force for muscular power; *secondly*, for the production of heat and the other molecular forces. The secreting function may be referred to the double action of the sympathetic—*i.e.*, as an involuntary motor system in reference to the contraction of the muscular tubes of the glandular tissues, and as a vaso-motor in reference to the adapted supply of blood from which chemical force is set free and the secreted matter separated. The experiments of Claude Bernard, Waller, Budge, Brown-Séquard, and others, have established these motor functions of the sympathetic. The influence which the spinal cord exercises over the production of heat has been proved experimentally by Weinhold, Wilson Philip, Krimer, Chossat,* and others,† and is shown by the conditions of the lower limbs in paraplegia. The influence of the spinal cord upon the functions of the abdominal viscera has also had abundant demonstration, both from pathological and experimental facts.

945. The relations between the sympathetic and intervertebral systems, as to the production of heat and chemical force, has been shown by experiments upon the sympathetic in the neck. Ablation of the superior cervical ganglion, or division of its commissural cord, leads to changes in the circulation in the head (internally as well

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* Chossat. *Influence du Système Nerveux sur la Chaleur Animale.* Dissert. Inaug. Paris, 1820.

† Compare Longet. *Anatomie et Phys. des Système Nerveux.* &c. (1842), vol. i. p. 302, *sqq.*

as externally), face, and eyes, similar to, yet widely different from, those which follow on removal of the Gasserian ganglion. Redness and capillary congestion occur in both cases; but in injury of the Gasserian ganglion, they are associated with diminished heat and vascular activity: in injury of the Sympathetic ganglion, with increased heat and vascular activity, which may be permanent. In a dog which M. C. Bernard experimented upon, the side of the head from which the cervical ganglion had been removed remained of a higher temperature than the opposite side for a year and a half; and was unchanged in this respect when the animal was destroyed, in the course of other experiments. The same eminent physiologist shows further, that when a low temperature and various changes in nutrition have been caused by division of the 5th nerve, the tying or cutting of the sympathetic in the neck, between the inferior and superior cervical ganglion, has interrupted the diminished temperature, as if it were remedial; so that a marked development of heat took place. Section of the left 5th caused the temperature of a dog's left ear to fall 3° C. below that of the right ear; at the same time the conjunctiva became red, the vessels dilated and gorged with blood, the eye glazed, the eyelids gummy, and the cornea dull. But when the sympathetic was divided on the left side, the temperature rose 6° C. on the left ear in a few minutes; while, at the same time, the right ear fell 6° C. in temperature.*

946. Dr Brown-Séquard shows very well, by his experiments, the part which the spinal cord plays in this business. Division of one posterior lateral half of the dorsal medulla is followed by increased heat and vascularity, and by hyperæsthesia of the skin on the same side. On the opposite side, the contrary takes place. There is less

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* *Leçons sur la Systême Nerv.* (1848), tom. ii. pp. 480-82.

blood sent to it; its temperature is lowered, nutrition is less active, and the vital properties of both nerves and muscles are less manifest.* He found that similar results were manifested in the two sides of the face, when the sympathetic nerve was divided in the neck.

947. Dr Brown-Séquard attributes these phenomena of increased heat, temperature, and nutrient activity, together with the increased sensibility, muscular irritability, and contractility; the increase of sweat and other secretions, and various other phenomena — all alike significant of increased activity in the vital processes—to *paralysis* of the vascular nerves, the consequence of section of the medulla or sympathetic. This paralysis allows the blood-vessels to dilate, and receive a larger quantity of blood; and it is upon this hyperæmia that the phenomena just mentioned immediately depend. This theory does not, however, explain why the vigour of the circulation, the temperature, and the activity of the vital processes generally, are *diminished* on the *opposite* side; for, according to both C. Bernard's and Dr Séquard's experiments, the diminution is not comparative but absolute, so that interruption of vital activity follows upon section of the *medulla spinalis*, as well as exaltation. Again, in section of the 5th nerve, we have vascular turgescence, the result, apparently, of dilatation of the capillaries with diminished temperature and imperfect vital activity; so that an increased flow of blood into the tissues cannot be the true cause of the exalted vital activity in the other case. The question indeed arises *in limine*, whether that can be properly designated paralysis at all, or the result of paralysis, which not only increases

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* Compare Dr Brown-Séquard's "Exper. and Clin. Researches on the Physiology and Pathology of the Spinal Cord," *Proceedings of the Royal Society of London*, vol. viii.

vital action, but restores it when diminished. Paralysis there probably is; but it seems to me that the term, as usually understood, is more properly applied to the results manifested on the side opposite to the section.

948. These facts seem to point rather to the conclusion that the true explanation is to be found in the crossed co-ordinating function of the spinal cord in regard to both the sympathetic and intervertebral systems. The excitation of the nutrient functions of the sympathetic is dependent upon a stimulus derived, in these cases, from the excito-nutrient or afferent fibrils, which enter the cord posteriorly. These, we have seen, must, according to the law of bilateral symmetry, decussate with the opposite side. Hence, section on the right side prevents action on the left. It is precisely the same relation, in fact, as is found between the hemispheres and the *corpora striata;* the hemispheres being a periphery, and the latter their co-ordinating ganglia.

949. The function of the anterior or motor columns of grey matter is dynamical as to nutrition of the nerve as well as in relation to motion (939). How far this may influence the motor function of the sympathetic is uncertain. But it is clear that we must classify the fibrils in the anterior roots which influence the sympathetic, as a motor system, with those which determine the contractions of the voluntary or striated muscles. In accordance with these views are the results of the experiments of M. Claude Bernard on the calorific powers of the anterior or motor nerves. He divided these, in a large vigorous dog, on the right side, so as to cut through those which constitute the motor fibrils of the lumbar and sacral nerves. The right extremity was paralysed, and in two hours and a half its temperature fell 1·5° C. On the other side, the power of motion was unaffected, and

the temperature of the limb rose 0·5° C. In three hours the temperature of the right leg had fallen 4° C.* These facts point to the conclusion that, when the one lateral half of the spinal cord is divided, there is loss of sensation, of nutrient energy, and of calorification on the opposite half of the body, as a consequence of the injury. So that while central action is imperfect in the injured half, it is intensified in the opposite or uninjured half of the spinal cord; and thus there is an exaltation of function as a consequence of the injury to the injured half. The exalted condition of that half appears to be like that of the lower half of the spinal cord, when reflex acts are vigorously developed in it, after complete division of the medulla.

950. There is, however, another probable mode of causation worthy notice. In animals devoid of nerves, movements are either rhythmical (847), or effected by the antagonising action of circular and longitudinal fibres, as in the Hydra and Acalephæ. These movements are homologous with the movements of the muscular tubes of the viscera and the vascular system, and of the system of non-striated muscles, and also with those effected by the flexors and extensors of the striated. Now, it is not improbable this differentiation is carried onwards into the nervous system, in which case there are separate substrata in the sympathetic ganglia for the longitudinal and the circular fibres in the tubular muscles, and in the cord for the flexors and extensors of the voluntary system. This hypothesis would necessitate a modification in the explanation just given, although it need not go so far as to require a system of "inhibitory" nerves. The sensory tract probably contains substrata by which all these varying *antagonistic* acts are correlated. In any case, it has

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* *Op. cit.*, tom. ii. pp. 488, 489.

a definite relation of some kind to movements, as is proved by the well-established fact, that the posterior grey matter increases in quantity *pari passu* with the anterior.*

951. It has already been shown that the nutrition of nerves takes place along the line of transit of the transeunt force (939). The question arises whether the intervertebral ganglia exercise an influence upon that segment of the spinal cord with which they are in relation, so that degeneration upwards, in the substance of the posterior cord, follows upon degeneration of the ganglion, or its commissures; or when all connection between them and the cord is severed. Dr Waller experimented with the view of solving this question. He divided the spinal cord of a dog between the third and fourth vertebræ. In twenty days the animal was killed. The wound of the cord had healed, but he found the anterior grey matter and the anterior roots of the nerves disorganised below the section; while, on the contrary, the posterior grey matter, both superficially and deeply in the substance, was disorganised to the extent of about two vertebræ above the section. This can be explained, as Dr Waller remarks, on the supposition that the posterior grey matter is a continuation upwards of the sensory nerves, and therefore, that the disorganisation was the consequence of interrupting the connection between them and the intervertebral ganglia.†

952. Dr Waller justly observes, that the results of these researches are well calculated to throw light upon many diseases of the nervous system. The nature of "spinal irritation," for example (the recognised consequence of morbid visceral influence on the cord), is

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* Sch. V. der Kolk, *On the Spinal Cord*, p. 52.

† "Septième Mémoire sur le Système Nerveux," *Comptes Rendus* tom. xxxv. (1852), p. 304.

thus elucidated. Nor is it difficult to see how spinal disease may result from ovarian, uterine, renal, or intestinal diseases, as well as from cutaneous affections, when the con-causes are present. But there is another more important law of action to be inferred from it—namely, that if the nutrient forces of the nerves and nerve-centres act in the line of direction of the transeunt forces or *vis nervosa*, the law applies equally to the nerves of special senses, as of the eye, ear, &c. We can thus, therefore, comprehend the mechanism of that education of the senses, and that development of the material organ which is the result of a proper exercise of any faculty.* The development of manual dexterity is also in entire accordance with the same law; for if we trace the course of the transeunt force onwards, from whatever source it reaches the centre, and to whatever centre it proceeds, we find that in all cases, coming in the first instance from the periphery, it enters the sensory tract to pass over to the motor tract, and so be delivered along the anterior nerves; so that when degeneration of the anterior nerves results from severance of their connection with the motor columns, it is because the same force which at its entrance to the spinal cord regulated the nutrition of the sensory tract, has been interrupted in its line of direction through the motor nerves to the muscles. Consequently, it equally follows, that evolution of the kinetic substrata must follow *pari passu* with that of the ideagenic; and that a quick perception necessarily implies a quick volition (832). It is obvious, too, that the line of degeneration in the encephalon will follow the same law; great excitement of the feelings, leading to imperfect activity of the sensory tract (say the *optic thalami*), will be followed by mental diseases involving the sentiments and feelings, and then by motor paralysis, as occurs in general paralysis of the insane (838). On the other hand, much intellectual or purely volitional activity is more likely to be followed by disease of the *corpora striata*.*

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* Part V. chap. xii. § 3.

953. Lastly, since the law of bilateral symmetry requires crossed action, the line of nutrient energy, and therefore of nutrient change, will be in the same direction. So that the law not only explains why lesion of the *corpora striata* is followed by paralysis of the opposite half of the body, but also why atrophy of one-half of the nervous system should co-exist with atrophy of the opposite half of the body.† It also explains the development of various chronic diseases of encephalic nutrition, by morbid changes passing along the sensory nerves. The facts of the case of M. Serres, by which he first demonstrated the pathological relations of the Gasserian ganglion to the cutaneous tissues, raises an important series of questions as to the decussating influence of the sensory "roots" of the nerve, considered as fibrils derived from the ganglion, as well as with reference to the influence of the non-decussating fibrils passing between the ganglion and the tissues. To the impaired influence of the latter upon the distribution of the blood and the nutrient function of the capillaries, we can attribute the congestion of the *dura mater* on the right side, the imperfect development of the cranial bones on the same side, and the atrophy of the right optic nerve, in addition to the disorganisation of the sensory branches in direct connection with the ganglion of the same side. But

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* Dr Gubler has recently applied Dr Waller's conclusions to an explanation of the pathology of softening of the brain caused by certain traumatic and inflammatory lesions (*Archives Gen. de Med.*, July 1859).

† See Sch. V. der Kolk's Case, *On the Medulla Oblongata*, Transl. p. 110.

does the influence of the ganglion extend to the nutrition of the cerebral ganglionic centre, as well as to the containing *dura mater* and bony structure? The general laws of development, and of co-ordinate vital action of parts, point to an answer in the affirmative; and the facts of the case recorded by M. Serres give an interesting confirmation of the doctrine. Upon careful examination, it was found that the disease had extended centrically both to the same and to the opposite side of the encephalic structures. Thus, at the right side of the annular protuberance, at the point corresponding to the insertion of the 5th nerve, the tissue was so disorganised as to be changed into a yellow gelatinous mass, for about the depth of two lines. Two small white fasciculi, the continuation of the motor root of the 5th, passed untouched through this mass. But it was the left side of the brain, and not the right, which presented marks of disease. The left hemisphere was softened, and the superior surface, anteriorly and posteriorly, of a pale yellow colour. The inferior surface was firmly adherent to the *dura mater;* and the whole of the middle lobe, as deep as the level of the "oval demi-centre" of the left side, was yellow and softened. The left *optic thalamus* and *corpus striatum* were somewhat softer than the same parts on the opposite side. The left hemisphere of the cerebellum was in the same condition as the left cerebral hemisphere, but less deeply involved; the left lateral ventricle was more distended than the right. The pineal gland was harder and larger than natural.*

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* *Anat. Comp. du Cerveau,* tom. ii. pp. 67–86. The important law of development of the nervous system which M. Serres has so fully established in this work—namely, that it proceeds from the circumference to the centre—is manifestly correlative with this law of functional and nutrient energy and morbid change of structure.

CHAPTER V.

ORGANOLOGY OF THE MEDULLA SPINALIS, OR SPINAL CORD.

954. A bony case encloses and protects the cerebro-spinal axis from mechanical injury. The cranium contains that portion subservient to mental life proper; the cavity of the spinal column that which is the centre of corporeal life, and in and through which the cranial portion acts. This column is made up of a series of bones (vertebræ), each of which is composed of two similar halves, and has in correspondence with each half a pair of nerves, an intervertebral ganglion, and a sympathetic ganglion.

955. While this bony case is the centre of movement and attachment of the muscles of the trunk and limbs inferiorly, it seems more purely protective as it rises into the hollow spheroid, the cranium. It is therefore, in that respect, a manifestation of the teleiotic idea of defence of the organism against mechanical injuries (659). Hence the formation of the osseous axis must be considered as due to a specialisation of the primordial vital forces, just as the co-ordinating structures within are specialisations of the fundamental law of design. The one is morphologically in relation to the other; consequently developmental changes in the form of the cranium, and of the vertebral column and its appendages, will follow upon modifications of the co-ordinating structures contained within them. These are primarily deter-

mined by external affinitive forces acting upon the organs of external relation, as modifications of the external conditions to which the organism is subject (250). They may follow, however, consecutively upon morbid changes in the nutrition of the cerebro-spinal axis, the result of morbid blood, or of modified activity of the nutrient nerves (953).

956. Fundamentally, each vertebra, with its connections, is homologous with every other. The cranium (it is now fully admitted) is an evolution of vertebræ; but as the law of differentiation and integration, by which the bones and the contained nerve-centres are evolved, applies equally to all the tissues of the vertebral segments, it follows that the scalp and face, with their appendages—the organs of the senses—are differentiations of the cutaneous tissues, and that all these, therefore, are under the same general laws in relation to the nerve-centres as the cutaneous tissues of the limbs and trunk.

957. The cerebro-spinal axis begins with the encephalic nodus, or *pons varolii.* With one or two exceptions, all above that point belongs to the mental faculties, all below to the corporeal functions. The *medulla oblongata* is the corporeal centre from which transeunt forces pass to the encephalon above, and to which they return after having made the circle of change. Besides this central function, the *medulla oblongata* is the co-ordinating apparatus for all the muscles of the throat, mouth, lips, tongue, nose, face, and the organs of the senses, in a vast variety of movements, by which the thoughts and feelings are expressed, the senses used, and air and food taken in.

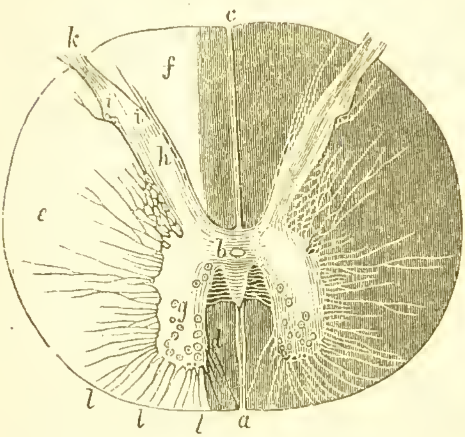
958. Looked at ideally, as an evolution of an archetypal idea, the spinal cord is constituted of an integrated series of bilateral co-ordinating centres, in which the

endowments of the sympathetic system are differentiated and specialised, in relation both with special organs of external relation and with the entire series of vital processes which the sympathetic regulates (603). When divided, it is found to be made up of two symmetrical semi-cylindrical halves, containing a crescentic two-horned nucleus of grey or medullary matter, covered externally by white or cortical matter; the convex border of each crescent is united to the other by commissural grey and white matter. The grey matter of the horns or *cornua* of the posterior portion differs from the rest in consistence, and is therefore distinguished as the *substantia gelatinosa*. A fissure separates the two halves externally at the front and the back, and a vacant space occupies the middle of the solid centre or commissures, termed the Spinal Canal. This canal corresponds to the ventricles of the brain; the fissures to the division between the hemispheres; and the transverse commissures to the soft commissures and *corpus callosum* which unite the two halves of the brain.

959. Looked at externally, the spinal cord presents three divisions on each side, termed the anterior, antero-lateral, and posterior columns. Tho anterior column is bounded externally by the line of attachments of the anterior roots of the spinal nerves; internally, by the anterior fissure. The posterior column is bounded, in like manner, externally by the attachments of the posterior roots of the spinal nerves; internally, by the posterior fissure. The antero-lateral columns lie between these. They are all made up of white or conducting nerve-fibrils.

960. We have already seen that the grey matter of the cord is divisible into two halves—namely, the anterior or kinetic, and the posterior or regulative (943). These constitute, together with the antero-posterior, transverse,

Fig. 16.



Transverse section of the human spinal cord, close to the third and fourth cervical nerves; × 10. (After Stilling.) *a*, anterior fissure; *b*, transverse commissure and spinal canal; *c*, posterior fissure; *d*, anterior columns; *f*, posterior columns; *e*, antero-lateral columns, extending from *k* to *d*; *i i*, *substantia gelatinosa*, or caput cornu of the posterior grey matter; *h*, cervix cornu of the same; *k*, posterior roots of spinal nerves, or sensory nerves and intervertebral commissure; *l*, anterior or motor roots arising from nerve-cells contained in *g*, the horns of the anterior grey matter.

and longitudinal nerve-fibrils which traverse them, two columns of vesicular tissue, the different parts of which have very different functions and relations, both central and peripheral. The posterior grey matter has behind it a strand of internuncial sensory fibrils (the posterior columns), which communicate between the cutaneous and visceral surfaces and the encephalic sensory centres; and the anterior half has a similar strand of internuncial motor-fibrils—the anterior columns, which communicate between the muscles (principally of the limbs) and the encephalic motor centres. Between these are the antero-lateral columns, the functions of which are still doubtful. It is probable, however, that the grey matter co-ordinates the action of the muscles of the thorax and trunk, and that the white matter is made up of internuncial fibrils, both volitional and corporeal; the latter communicating with the centres of aëration, alimentation, and circulation in the *medulla oblongata*;—the whole forming the so-called "respiratory tract." These structures all contain plexuses or definite groups of cells, which may be distinguished as the substrata of adapted actions, and which differ as they are in direct relation with motor nerves (kinetic), or with the substrata of motor nerves (regulative). The latter in the encephalon are sensory and ideagenic substrata (325).

961. *The Sympathetic Substrata.*—The sympathetic system proper, although eliminated from the spinal axis of vertebrates (903), is still in symmetrical relation with each segment. Hence it may be inferred, *à priori*, that each ganglion of the sympathetic has its correlative co-ordinating substratum in the cord. This is rendered the more probable from the fact that the sensitive nerves on the skin correspond to the muscles below, so that both are derived from the same spinal segment (906). This, too, is the case with the sympathetic nerves of the skin.

962. *The Cilio-Spinal Region.*—The visceral sympathetic is co-ordinated into centres as plexuses situate externally (867). These have probably each their co-ordinating spinal substratum. Thus the cœliac axis seems to have a corresponding regulative centre on the spinal cord, by which all the gastro-intestinal structures and functions are brought into co-ordination; and so also with the thoracic, hepatic, splenic, renal, hypogastric plexuses. The substrata of these have not, however, been discovered. It is otherwise with the regions of the neck and head. MM. Waller and Budge found that by galvanising the oculo-motor, or third pair of nerves, the iris, contracted immediately; but on galvanising the sympathetic, it slowly dilated. The influence of the sympathetic appeared to be limited downwards, however, to the last cervical ganglion. But they also found that if they galvanised that portion of the spinal cord in a rabbit which extends between the first cervical and

the sixth dorsal vertebra, they produced the same effect. Hence that portion is the spinal centre of the cranio-cervical sympathetic system. MM. Budge and Waller termed it the *cilio-spinal region.* The *cilio-spinal centre,* or centre of this region, as indicated by the point of maximum intensity, was found in the frog to correspond to the articulation of the second and third dorsal vertebræ, and to the origin of the second dorsal pair of nerves.* Whether in man this is the range of the cervical sympathetic is doubtful; but that these ganglia exercise an important influence on the circulation, both externally on the face and internally on the *dura mater* and brain, seems to be well established (934, *sqq.*) The connection of goitre with imperfect development of the brain in cretinism, and with that peculiar form of chlorosis in women accompanied with morbidly prominent eyes, both point to the same relations.†

963. *Sacral Substrata.*—The influence of the ovaria and testes upon the cutaneous tissues of the face, in determining pigment-deposit (as in pregnancy, and other pathological states), and on the functional activity of the hair-follicles and sebaceous glands, so that the peculiar facial characteristics of the sexes are developed, prove that the hypogastric plexus is in relation with the sympathetic of the cranio-facial, cervical, and thoracic regions. The sexual appendages of the head, face, and thorax; the size of the larynx and of the thoracic parietes; the nutrition of the heart (826), and the activity of

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* Recherches sur le Système Nerveux, par MM. Budge and Waller, *Comptes Rendus,* tom. xxxiii. p. 372.

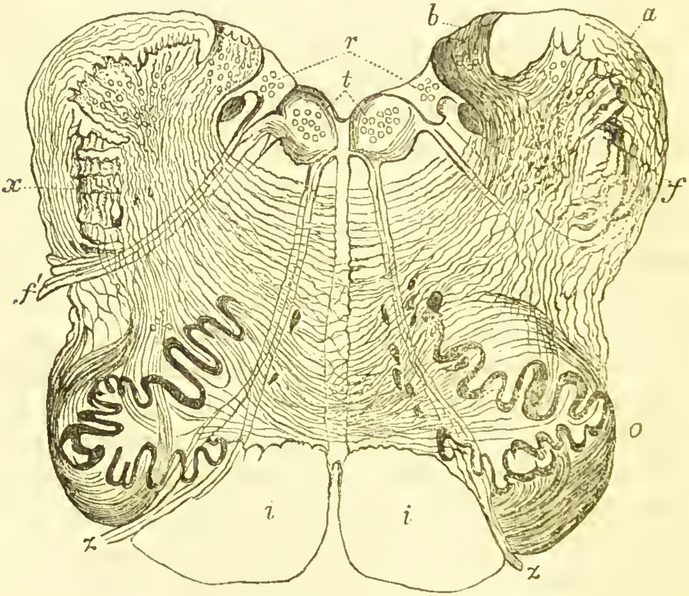
† I might add to these, facial deposit of pigment in women, œdema of the eyelids, and local hæmorrhages, which, in my clinical course, I show to be connected with centric irritation of the cervical or facial sympathetic, derived, probably, from the excitor action of the uterus and ovaria.

various encephalic organs of the instincts, are so distinctly connected with activity of the generative glands (684), as to leave no doubt whatever that there is a direct connection between the anterior and posterior integrations of the nervous system. It is possible that improved methods of research may enable microscopists to detect these anatomical relations, which the physiological and pathological phenomena so clearly indicate.

964. *Intervertebral Substrata.*—The intervertebral ganglia seem to be connected by the intervertebral commissures (fig. 16, *k*) with two tracts of substrata in the spinal axis. One of these will perhaps be found in a continuous column of grey matter discovered by Mr J. L. Clarke, which he terms "the posterior vesicular column." One portion of it is developed from the outer and posterior part of the *cervix cornu* of the *posterior* grey matter, and ends in the restiform body containing the restiform ganglion. The other is developed from the inner and posterior part of the *cervix cornu* of the posterior grey matter, and ends in the post-pyramidal ganglia (875, and fig. 3). In this column the fibrils of the posterior roots are most intimately connected with the nerve-cells, both longitudinally and transversely. They also send fibrils to the lateral columns and the *substantia gelatinosa.* Mr Clarke found these columns to commence below the lumbar enlargement; to become thicker there, and in the cervical enlargement, from the increased number of nerve-cells present; and finally to end in the restiform and post-pyramidal ganglia of the *medulla oblongata* (fig. 17, *a b*); which in their turn are brought into intimate co-ordination with the cerebellum by means of a bilateral commissure, termed the restiform strands. It is very probable that these two vesicular tracts will be found to be subservient to the cutaneous and visceral afferent systems

respectively, and have their appropriate regulative substrata; the restiform being the ganglia of the latter, and the post-pyramidal of the former.

Fig. 17.



Transverse section of human *medulla oblongata* a little above the point of the *Calamus Scriptorius*, and through the olivary bodies. (After J. L. Clarke.)

a, Restiform body, containing the restiform ganglion, or vesicular substance, developed from the *outer* and posterior part of the *cervix cornu posterioris*. *b*, Posterior pyramid, containing the post-pyramidal ganglion, or vesicular substance, developed from the *inner* and posterior part of the *cervix cornu*. *f*, Grey tubercle of Rolando, or *caput cornu posterioris*. *o*, Olivary body. *i i*, *Anterior* pyramids. *z z*, Roots of *hypoglossal* nerves. *f*, Roots of *vagus* nerve. *r*, Vesicular nuclei of spinal *accessory* nerves. *t*, Vesicular nuclei of hypoglossal nerves. These four nuclei, or vesicular columns, form the *floor* of the fourth ventricle at this part of the medulla. *x*, Superficial arciform fibres, extending backwards round the restiform body and its vesicular nucleus or ganglion.*

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* For further explanations of the development of these parts from the upper end of the *medulla spinalis*, and their mutual relations, see "Memoir on Medulla Oblongata," *Phil. Trans.* Part I. 1858, figs. 10, 12, 15, 16, 19, 23, and 28. Also, "Further Researches on the Grey Substance of the Spinal Cord," *Ibid.* 1859, Part I. pp. 437-38.

965. *Substrata of the Pneumogastric and Trigeminal Ganglia.*—The tissues endowed with sensory nerves in connection with these intervertebral ganglia have such very special and striking relations to each other, that there cannot be a doubt they are brought into co-ordination by a special group of regulative substrata. These seem to be contained in a lateral column of grey matter, continuous upwards with the *caput cornu* of the posterior grey matter to a large group of nerve-cells in the *medulla oblongata*, known as the tubercle of Rolando, and which is in close contiguity with the restiform ganglia (fig. 17, *f*). This column is traversed by the roots of the pneumogastric and glosso-pharyngeal nerves, and is finally the principal nucleus of the 5th nerve, or trigeminus. The "grey tubercle" (which, like the restiform ganglia, is in direct commissural connection with the cerebellum) is generally considered to consist of the gelatinous substance; but Mr Clarke states that in reality it includes the whole dilated extremity of the posterior cornu, or *caput cornu posterioris*.

966. As both the glosso-pharyngeal and the pneumogastric have ganglia on their posterior roots; and in particular, as the former has been clearly shown to belong to the same class of nerves as the spinal, sensory, and trifacial nerves,*—we must look upon this ganglionic tract as part of the great co-ordinating centre of the intervertebral ganglia. It appears to differ in size or development in different portions of the spinal cord. In the upper part of the cervical region it is less expanded, the *caput cornu Post.* being long and pointed (Fig. 16, *i*, *i*), or pyramidal; it is broader and more rounded in

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* Dr J. Reid, article "Glosso-pharyngeal Nerve," *Cyclop. of Anat. and Phys.*, vol. ii. p. 499. Professor Müller, *Archiv. für Anat.*, &c., Band i. (1837), p. 276.

the lumbar enlargement of the cord, corresponding to the point of origin of the nerves of the lower extremities. It also appears broader in the *conus medullaris*, or terminal portion of the spinal cord, where the grey matter is less deeply covered by the white or longitudinal commissural fibres. The gelatinous substance at this point becomes at first continuous between each symmetrical half of the cord, and presents a concavity which looks backwards to receive the posterior columns; it then, as it descends through the *filum terminale*, rises to the surface in the middle line, and extends directly across; meanwhile the posterior columns become gradually shallower and at length disappear, except at the sides, so that the gelatinous substance behind is covered only by the *pia mater* of the cord.* This may be considered the lower border of the intervertebral ganglionic centre, and in connection with the *sacral* substrata of the pelvic organs.

967. *Motor Respiratory Substrata*, or the *Lateral Columns.* —The motor nerves of the organs of respiration are of two kinds; *first*, those which belong to the sympathetic and invertebral systems, and which are distributed to the skin and bronchi; *secondly*, those which are purely motor, and belong to the external respiratory system of Sir C. Bell. In 1851, Mr J. L. Clarke made out a distinct tract of grey matter in the spinal cord, situate laterally between the anterior and posterior grey matter, and united by a transverse commissure of fibres, which he terms the *tractus intermedio-lateralis*. It is connected with the outer or lateral portion of the *cervix cornu posterioris*.† It consists for the most part of oval, fusiform,

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* Mr J. L. Clarke. *Phil. Trans.* 1859. p. 454.

† "Further Researches on the Grey Substance of the Spinal Cord," *Phil. Trans.* 1859, p. 445, and *ibid.* 1851, p. 613.

or pyriform and triangular cells, somewhat smaller and more uniform in size than the cells of the anterior cornu. It is larger at the upper part than in the middle of the dorsal region. On the one side it projects further into the lateral columns, and on the other tapers onwards across the grey substance to near the front of the vesicular columns. It is prominent in the lumbar region, but its cells are not so numerous there as in the upper dorsal. In the region of the upper cervical nerves, it is traversed by the roots of the spinal accessory nerve, as they bend forward to the anterior cornu to emerge as motor nerves; and it corresponds in the *medulla oblongata* to the nuclei of the spinal, accessory, and hypoglossal nerves (fig. 17, *r*, *t*). This column seems to be the motor column of the respiratory muscles of the thorax and abdomen. Sch. V. der Kolk describes a very similar tract in connection with the afferent respiratory nerves (*vagus*), and shows that Schiff's vivisections prove these lateral columns to be subservient to the movements of the trunk—that is, of the thorax and abdomen.*

968. The gastric portion of the vagus or pneumogastric nerve (*sympatheticus minor* of the older anatomists), seems to subserve the functions of the sympathetic in some of the lower Vertebrata (the Cyclostomes and Myxinoid Fishes); and to be homologous, as to a portion of its centres and branches, with the stomato-gastric of invertebrates. The glosso-pharyngeal nerve, which is usually only associated with the vagus, is observed to take origin in crocodiles in common with it, while both are united by a common intervertebral ganglion. In fishes, a remarkable branch is seen to be given off, sometimes from the posterior margin of the ganglion, sometimes from the anterior roots of the vagus, which runs in a straight line as far as

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* *On the Spinal Cord* (translated by Mr Moore), pp. 26, 185.

the tail. In many fishes, after having given off a superficial filament which follows the commencement of the lateral line, the trunk of the nerve passes straight backwards, embedded in the lateral muscles, and receives filaments from every one of the spinal nerves, quite distinctly from the intercostal nerves, giving off also branches to the skin, which pass through all the intervals of the muscular layers. This seems to be a distribution homologous with that of the respiratory nerves in the Articulata. In Amphibia, a branch of the sympathetic unites the trigeminal ganglion and vagus within the skull; such union takes place also in man. Hence, while the organic functions of the viscera are co-ordinated by regulative substrata, they are also brought into immediate relation with the motor substrata of the instincts, appetites, and sentiments, in the *medulla oblongata.*

969. *The Pathemic Substrata.*—It is well known how, in active states of feeling, termed Emotions and Passions (440), the skin, heart, lungs, and viscera generally, have their vital activity so altered, that their muscular movements are arrested, perverted, or exalted; and the secretions of the glandular structures either increased or otherwise morbidly modified. Thus, anger sometimes so modifies the milk of the nurse, that it acts like a poison on the infant. Now, there must be some centre for the transmission of the dynamic influence by which these emotional or pathemic changes are effected in these states of consciousness. It seems probable that this centre is to be found in the intervertebral and respiratory substrata. If this prove correct, then the cerebellum must be looked upon as exercising an important influence on all the sympathetic, emotional, and pathemic changes, inasmuch as it is in direct commissural connection with these columns.

970. The organs of respiration in vertebrates, and the facial muscles proper, constitute together the organ of expression of the desires, emotions, thoughts, will. Every passion reflects its image in the modes of breathing and vocalisation; each state of consciousness is distinguished by its appropriate cry or other sounds; each emotion by its facial expression. The language of lower social animals, thus developed, is intelligible to each other; the human speech is perfectly intelligible to many of the social animals, and is imitated by several. Hence, the organs of respiration, like the hand and other organs of touch, have special relations to the organ of thought.

971. These substrata also bring the afferent nerves of the skin and face, and of the viscera, into relation with the motor ganglia of the respiratory organs. It is probably through these that the application of cold to the surface causes respiratory movements and gasp. Through these, too, convulsive movements of the respiratory muscles and of the organs of voice are excited, by impressions on the visceral surfaces. Being connected commissurally with the cerebellum, they also bring the whole of the sensory nerves into connection with that extensive mass of vesicular neurine.

972. *The Motor Substrata of the Trunk.*—As it is necessary to harmonize the muscles of the trunk with each other, and with those of the limbs, groups of appropriate nerve-cells would be required in all movements of the body as a whole, or in special movements in relation to the thoracic and abdominal viscera. These muscles of the trunk act in sets; bending the body backwards, forwards, or sideways; fixing the thorax and pelvis, or assisting in the expulsion of things from the visceral cavities, as in defæcation, urination, or parturition. That there are differentiations of the spinal kinetic substrata in adap-

tation to these various movements, is probable from the phenomena of tetanus, of which there are named varieties according as the trunk is bent backwards, forwards, or sideways. All anatomical research indicates that the spinal cord is the seat of the morbid changes upon which these convulsive movements depend, and not the cerebellum.*

973. *Substrata of the Four Extremities.*—Every limb moves as a whole; but each limb has sets of muscles, such as pronators and supinators, adductors and abductors, flexors and extensors, which combine together, and move the limb, or portions of it, in definite directions through space. Hence, we must look for co-ordinating apparatus appropriate to each of these varied movements; namely, flexion and extension, adduction and abduction, pronation and supination, and a total co-ordination of all. It is an interesting question, whether there are nerves and substrata appropriate to flexion and for extension (950). Bellingeri came to the conclusion that the anterior columns, and the anterior roots of the nerves, supply the flexor muscles; the posterior, the extensors. This conclusion is probably erroneous; nevertheless, there is a physiological difference between flexion and extension of some importance. Flexion is much more automatic than extension; extension is more volitional than flexion. Hence, in "dropped hand" and hemiplegia we see the extensors of the hand and fingers wholly paralysed, leaving the flexors to bend the fingers tightly into the palm. Further, the sympathetic presides over the class of peristaltic movements; now these are excited by an alternate contraction of longitudinal and circular fibres, corre-

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* See this opinion of Volkmann's well supported by Sch. V. der Kolk, and an explanation of the experimental results obtained by Flourens and others, in his work *On the Spinal Cord*, p. 72.

sponding to flexors and extensors. But the one class of fibres may be paralysed, and not the other; this is seen in the permanent dilatation or contraction of the iris (962). Various experimental and pathological facts also point to the conclusion that there are kinetic substrata in the spinal cord for pronation, supination, adduction, abduction, and the like. The most conclusive fact of this kind is the withdrawal of a limb from irritation by a reflex act, when the continuity of the spinal cord with the encephalon is interrupted.

974. Taking the limbs as a whole, it seems more than probable that the ganglionic centre to each consists, as in the sympathetic (920), in the integration of several ganglia. Thus the brachial plexus, which supplies the upper extremity, is constituted of the anterior branches of the four inferior cervical and first dorsal nerves; and the lumbar plexus, which supplies the lower extremity, is constituted of the anterior branches of the five lumbar nerves. As in each case there must be five intervertebral ganglia, and five spinal ganglionic, if not five sympathetic centres, in correspondence with the nerves, we may infer that the five elements of which the hand is composed correspond fundamentally to these five ganglionic centres. Consequently the mass of vesicular neurine which occupies the axis of the spinal cord at the point of junction of the nerves of the extremities, may be considered as the integration of five spinal segments. This is undoubtedly one of the general laws of development in the higher invertebrates amongst the Radiata and Annelids (247, 718). If it is as applicable to man as to the higher *insecta*, then he is constituted of seven segments, each consisting of five zoonites. This would indicate five elements for the head.*

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* There is much difference in opinion amongst anatomists as

975. The human hand, the extremities and tail of the Quadrumana, the trunk of the elephant, and similar structures, are in relation with a special sense—namely, that of touch—and are therefore in direct relation with the encephalic ganglia. The human hand, in particular, being the instrument by which man represents his highest notions and imaginations in writing, painting, sculpture, music, and the arts generally (852), is as much and as directly in relation with the hemispheres as the organs of voice or of expression. Hence, in this and analogous instances in lower animals, there are special encephalic centres by which the muscles of these instruments of the sentiments, the imagination, and the intellect, are co-ordinated in various ways to subserve and express the successional states of consciousness, and their corresponding teleiotic ideas. It seems probable that each limb has for this purpose a direct communication by motor strands with the cerebrum, and that the anterior pyramids, along which the will-force passes to the muscles, are thicker in Carnivora, apes, and man, than in hoofed animals (as horses and oxen), on account of the higher development of the extremities into fingers and toes.*

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to this point. Goethe and Maclise count six; G. St Hilaire seven; Oken, Bojanus, and Owen, four; Cuvier, Spix, Carus, and Meckel, three. A curious case, which may be taken as an illustration of this doctrine, has been recorded by Valentin (*Repertor. für Anat. and Phys.*, Band i. p. 330). He knew a girl who had a row of imperfectly organised wart-like projections, representing the fingers of the left hand, the defect being congenital. Yet she had constantly the internal sensation of a palm of the hand and five fingers on the left side as perfect as on the right.

* Sch. Van der Kolk. *Op. cit.*, p. 97.

CHAPTER VI.

ORGANOLOGY OF THE MEDULLA OBLONGATA.

976. The *medulla oblongata* being situate between the systems of encephalic and spinal ganglia, is a common centre of the substrata of both. It contains three fundamental kinds of organs—namely, *first*, those which are proper to it as a series of integrated segments of the spinal cord; *secondly*, those which belong to it as the centre of the corporeal ganglia proper, and therefore of all the vital functions (903–4); and, *thirdly*, those which are commissural between it and the encephalon on the one hand, and the spinal cord on the other. In the first class are those which co-ordinate the structures of the head and face, including the mouth and throat; in the second, those which co-ordinate the movements of the body, or of its various systems of respiration, circulation, digestion, elimination, &c.; and in the third, the strands, anterior and posterior, which pass from the spinal cord and medulla itself onwards to the encephalon.

977. The relations of the *medulla oblongata*, considered as a series of spinal ganglia, are twofold. First, the cutaneous tissues of the corresponding segments (namely, of the face and jaws) are highly differentiated into systems of organs. Thus, the globe of the eye, its muscles, its eyelids, and its separate parts, are all evolutions of the ectoderm (899), as the retina is a differentiation of a nerve of touch (324). So also with the various parts of

the ear. The facial muscles, in like manner, are differentiations of the cutaneous muscular system, to which belong structures like the *dartos*, or the muscular fibres of the hair-follicles. These are all co-ordinated in pathemic states. Hence it is that often, when the facial muscles express the feelings, the skin also "creeps" or contracts, and the hairs rise up. Thus, the mane is erected in emotional states of the Carnivora, the neck-feathers in the Gallinacea, &c. The nerve-centres of these structures belong, therefore, to the pathemic system, which includes (as we have seen) both the intervertebral and sympathetic systems (969).

978. The portions of the head and face which correspond to the limbs are the jaws, lips, tongue, and larynx. The jaw is not simply an organ of alimentary prehension; it is largely used for the same purpose as a hand.* It is admittedly a part of the vertebral system. The tongue-bone (*os hyoides*) is also considered to correspond to the ribs of cervical vertebræ.† The corresponding motor nerve is the hypoglossus; and the corresponding sensory nerve, so far as the tongue is concerned, as an organ of touch and taste, is the lingual branch of the 5th. The larynx, as part of the hyoid segment, is supplied with branches from the vagus which correspond in distribution and function to the sympathetic; the recurrent nerve being distributed to the arytænoid or sphincteric muscles of the larynx. These probably act the same part in vocalisation as the lips, which are also sphincteric in their character. The pharynx belongs to the visceral system, and therefore its nerves also. The lips and tongue are differen-

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* A recent traveller reports that the women of some of the Indian tribes in North America can put a piece of bark into their mouths, and cut out a pattern upon it with their teeth.

† Mr Maclise, Art. "Skeleton," *Cyclop. Anat. and Physiology*. vol. iv. p. 658.

tiated into organs of prehension in most animals; their nerves, therefore, belong to the voluntary as well as involuntary system.

979. The *medulla oblongata*, considered as a corporeal centre, is the homologue of the entire encephalon, which is a differentiation of it. In the lowest animals, we have seen that it is a co-ordinating structure of the alimentary and visceral tissues of the simplest kind, being both subservient to the vegetative processes and to those of external relation. Its fundamental functions as a cephalic centre are perhaps best shown in the minute anatomy of the cephalic integration of the common earth-worm, the *Lumbricus terrestris*. In this animal the organs of external relation are reduced to their utmost simplicity. The eyes are quite rudimentary; the hearing seems to be nothing more than a sense of touch seated in the skin; taste and smell appear to be no more highly developed than in the Hydra or Amæba, so far as special organs are involved. This apparatus shows very clearly the fundamental elements of the brain. The stomatogastric system is evolved into a simple organ of prehension in relation with the alimentary canal through the ganglionated sympathetic plexus *d*, fig. 18 (see also fig. 8), and which is also in immediate connection with the cephalic lobes. The same lobes guide the movements of the entire animal, under the influence of affinitive impressions derived from the skin-sense of hearing and from the rudimentary eyes; for it is well known to anglers how quickly the worm will make its way to the surface when the earth in which it lies is shaken by a spade, and, on the contrary, how quickly it will withdraw into the earth on the approach of the hand.*

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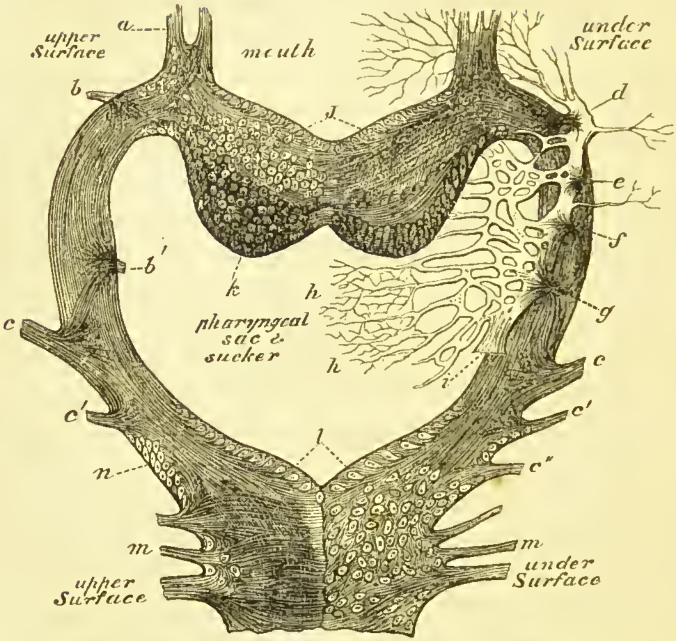
* Mr Clarke observes, as to the appetites of the animal, "It has been seen that the *upper* lip is supplied by the *cephalic* nerves,

Fig. 18.



The Cephalic Ganglia and their connection in the Earth-worm. *Explanation* — *a*, Cephalic nerves, proceeding from outer and anterior part of the cephalic lobe *k*; *b b'*, Roots of the pharyngeal ganglionic chain, which has been removed on the left side: they proceed from the *under* surface of the pharyngeal *crus* or collar (see opposite side of figure); *c c' c''*, Branches running between the pharyngeal collar and the muscles and integument of the *lower* lip; *d*, First or anterior ganglionic enlargement of the pharyngeal chain of the right side. It arises from the shoulder of the pharyngeal collar by a branch or root (see opposite side at *b*), the fibres of which converge from three sources: 1. From the cephalic lobe; 2. from the posterior part of the collar, in which they are probably continuous with other branches; 3. from the cephalic nerves of the same side, with the fibres of which they are directly continuous. (The cephalic nerves supply the muscles and mucous membrane of the *upper* lip.) Between this first root of the pharyngeal chain and the cephalic nerves, a small row of cells border the shoulder of the

and that these nerves are continuous at their roots (through the pharyngeal collar) with the root of the first ganglionic enlargement of the pharyngeal chain, branches from which supply the mouth, and communicate with the plexus distributed to the pharyngeal sac and sucker. These curious and extensive communications are extremely interesting. 1. The fibres connecting the ganglionic enlargements of the pharyngeal chain with the cephalic lobes may have the office of harmonising the condition of those collar, and extend for some distance into the cephalic nerves. From the anterior extremity of the first ganglionic enlargement (*d*) of the pharyngeal chain, branches proceed forward to form a network through the muscular bands, and muscular and mucous coats of the mouth as far as the lips, where it *appears* to communicate with the terminal branches of the cephalic and other nerves which supply the outer tubes or muscular rings; *e f g*, Roots by which the three posterior enlargements of the pharyngeal chain take their origin from the pharyngeal collar. From the inner border of the pharyngeal chain, a ganglionic plexus, including round or elliptical interspaces, proceeds towards the pharyngeal sac and sucker, upon which it spreads in a fine network (*h*), interspersed with minute ganglia, and communicating with its fellow of the opposite side as well as (beneath the cephalic lobes) with the plexus distributed to the mouth from the first ganglionic enlargement, *d*. At *g*, on the right side, and at *b* on the left side, fibres from the pharyngeal plexus and from the lowest enlargement of the pharyngeal chain may be seen crossing the collar obliquely to enter the branch (*c*) which supplies the muscles and integument of the *lower* lip; *h h*, Plexus terminating in a network or anastomosis of individual fibres: the dots at the junction of the branches indicate the ganglionic points; *i*, Offset of the posterior enlargement of pharyngeal chain, sent backwards to form a plexus on the œsophagus; *J*, A very regular row of nerve-cells along the anterior border of the cephalic lobes; *k*, Posterior, thick and rounded border of left cephalic lobe; *l*, A regular row of pyriform nerve-cells along the anterior border of the first abdominal or sub-œsophageal ganglion; *m m*, Nerve-roots proceeding from the sides of the sub-œsophageal ganglion. On the right side its *under* surface is seen to be studded with nerve-cells, amongst which the fibres of the nerve-roots form an intricate interlacement. On the left or *upper* surface, only a few scattered cells are seen around the roots, of which many fibres proceed nearly transversely and horizontally from the opposite side.*

980. Now, if the cephalic centre of the Lumbricus were integrated into one ganglionic mass, it would represent a *medulla oblongata*, the principal element of which is a stomato-gastric system, with cutaneous sense-nerves in

lobes with the state of the pharynx and alimentary canal—that is, it may excite in the former the sensation of hunger, &c., as well as be the instrument through which the cephalic lobes control the movements of the pharyngeal sucker, and project it forward through the mouth. 2. The connection of at least the first enlargement of the pharyngeal chain with the cephalic nerves which send branches to the *upper* lip, as well as the connection of the last ganglionic enlargement with the branches *c c′* of the collar, which supply the *lower* lip, may serve to harmonise the sensibility and movements of the lips with the condition of the alimentary tube, and be the instrument in exciting a consentaneous or rapidly successive action in that beautiful series of muscular movements by which the lips are retracted, the mouth is everted, and the pharyngeal sucker is dragged forward to grasp the food.

* I have to thank Mr J. L. Clarke for this interesting drawing. It forms part of the original researches into the anatomy of the earth-worm already referred to, p. 361.

connection with motor nuclei, by which the movements of both the head and the entire animal are co-ordinated. The entire system of organs, and nerves, and nerve-centres, of the face and head, in the vertebrates, are necessarily wanting, but the teleiotic homologues are there; so that we must look in the *medulla oblongata* of vertebrates for the centres of the cerebral nerves, as well as of the so-called spinal or afferent nerves of the body.

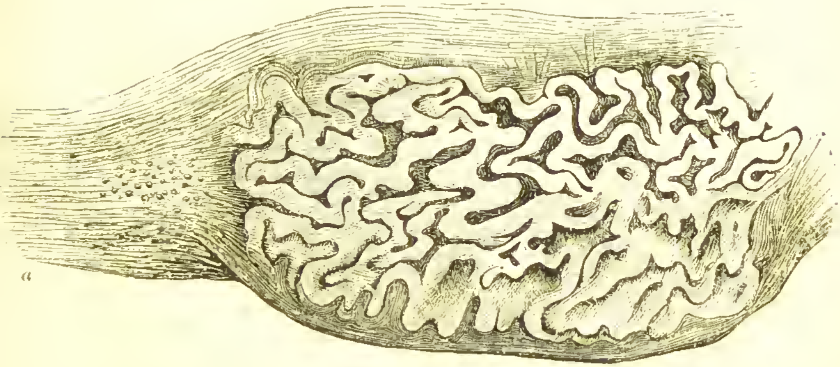
981. The anterior and posterior pyramids of the *medulla oblongata* pass upward into the encephalon; the restiform and post-pyramidal ganglia, and the tubercle of Rolando, are centres to structures below. There remains, therefore, to examine the centres of deglutition, speech, facial expression, and motion of the muscles of the organs of the senses. The latest researches place most of these in the olivary bodies, or the ganglia proper of the *medulla oblongata.*

982. The *olivary ganglia* (fig. 17, *o*) are situate behind, and to the side of the anterior columns or pyramids (*i i*), between these and the lateral columns; the roots of the hypoglossus (*z z*) and vagus (*f′*) bounding them anteriorly and posteriorly. They consist of folds or laminæ constituted of an immense number of small ganglionic cells (875), and have a striking resemblance to the cerebral hemispheres. A number of transverse commissural fibres pass between the two lateral ganglia, through the raphe or commissure of the *medulla oblongata*, thus combining them into common action. Superiorly, a tract of fibres, the olivary tract or column, passes upwards from the upper end of the ganglion to continue onwards into the *pons Varolii*, and bring the olivary ganglia into relation with the *tubercula quadrigemina* and hemispheres above, and the anterior columns below.

983. Some difference of opinion is expressed as to the

exact course of these commissures upwards, but all agree that they pass through a ganglionic mass of nerve-cells in

Fig. 19.



Longitudinal section of the human olivary body, showing the convolutions of the grey laminæ, and the commencement of the olivary tract or column *a*.

the *pons Varolii*, termed the *locus niger* (fig. 20, *l n*). The olivary bodies seem to be developed within the antero-lateral columns, as if they were a special motor differentiation of the antero-lateral grey matter. The olivary column, in its course upwards, passes through the *pons Varolii* (fig. 20, *o t*, *o t*), on a plane posterior to the anterior pyramids, from which they are separated by about a quarter of an inch of the *pons*. Higher up some of the fibres join the pyramids, and form part of the *crura cerebri*, and thence upwards to the hemispheres. These run partly behind, partly on the outside, partly through the *locus niger*. Sir C. Bell describes this fasciculus as emanating exclusively from the olivary body; Mr Solly terms it the olivary commissure.* Another band of fibres, emanating from the column in the *pons*, runs to the optic tubercles.

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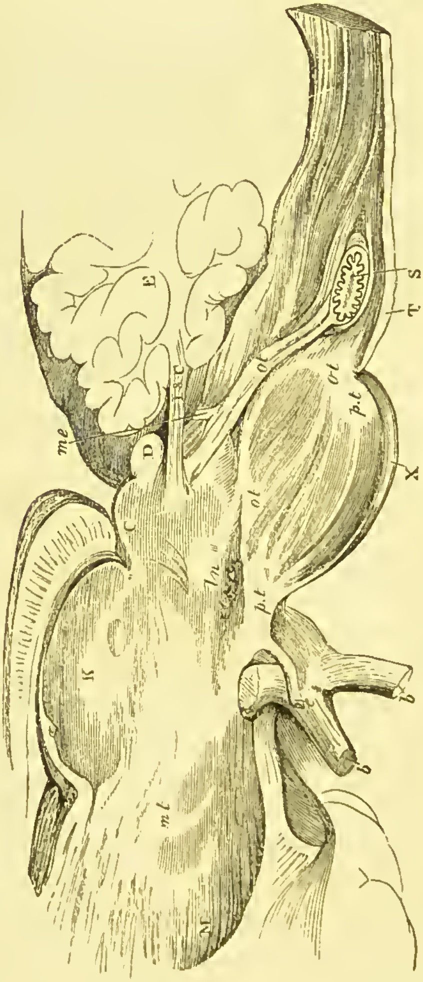
* *The Human Brain*, 2d edit. p. 240.

984. If these olivary columns be traced downwards, it is found by Dr Reid and Mr Solly that they are continuous with the line of origin of the anterior roots of the spinal nerves. Where the column encloses the olivary ganglion, the *portio dura*, or facial nerve, is attached to its

Fig. 20.



Course of the anterior pyramids and olivary columns through the *pons Varolii* and *civis cerebri* to the hemispheres, and the connection of the motor root of the 5th with the olivary column. C, *Anterior optic tubercles*; D, *Posterior*; E, *Cerebellum*; K, *Optic thalamus*. M, *Corpus striatum*; P, *Corpus callosum*, or commissure of the hemispheres; S, *Olivary body*; T, *Anterior pyramids*; X, *Pons Varolii* (transverse commissure of cerebellum); I & C, *Commissure of brain and cerebellum*; *b b*, *Optic nerves*, or 2d pair; *l n*, *Locus niger*; *m e*, *Motor root of 5th pair*; *o t*, *o t*, *Olivary column*—one portion in connection with the optic tubercles D C, another passing through the *pons Varolii*; *p t*, *Anterior column* passing through the *pons* to the motor tract in the *corpus striatum* M.

outer margin, and the hypoglossal and abducent nerves have also a connection with it. The motor root of the 5th can be traced to that portion of the column which proceeds to the optic tubercles; and the trochleator nerve is attached to the same band of fibres just before it enters the former.* The olivary body is thus intimately connected with all the motor nerves, and with the hemispheres and optic tubercles.

985. The *accessory olivary ganglia*, discovered by Stilling, agree in structure and composition with the olivary ganglia, with which they are closely connected by commissural fibres. They have peculiar relations with the hypoglossal nerve, which passes between them and the olivary bodies, inasmuch as fibres extend between them and the hypoglossal ganglion. This latter, like the olivary ganglia, is remarkably crowded with multipolar ganglionic cells.

986. Although the olivary ganglia seem homogeneous, it is probable they are multiple in structure, and are constituted by the integration of two or more distinct ganglia of the class. Schr. V. der Kolk has discovered two distinct ganglia in certain of the vertebrates, which he has termed the superior and the inferior. The superior is found high up beneath the *pons Varolii*, and behind the "trapezoid body," a structure seldom found in man. It is situate between the nucleus of the facial nerve (with which it is in close relation by numerous fibrils) and the origin of the abducent nerve of the eye. It is most highly developed in the Carnivora (dog, cat), smaller in the Rodentia (rabbit, *cavia aguti*), and smaller still in the Herbivora (as the horse, ox, ass). It is very small in the ass, and almost rudimentary in birds. The inferior olivary body of the lower animals seems to correspond to the accessory

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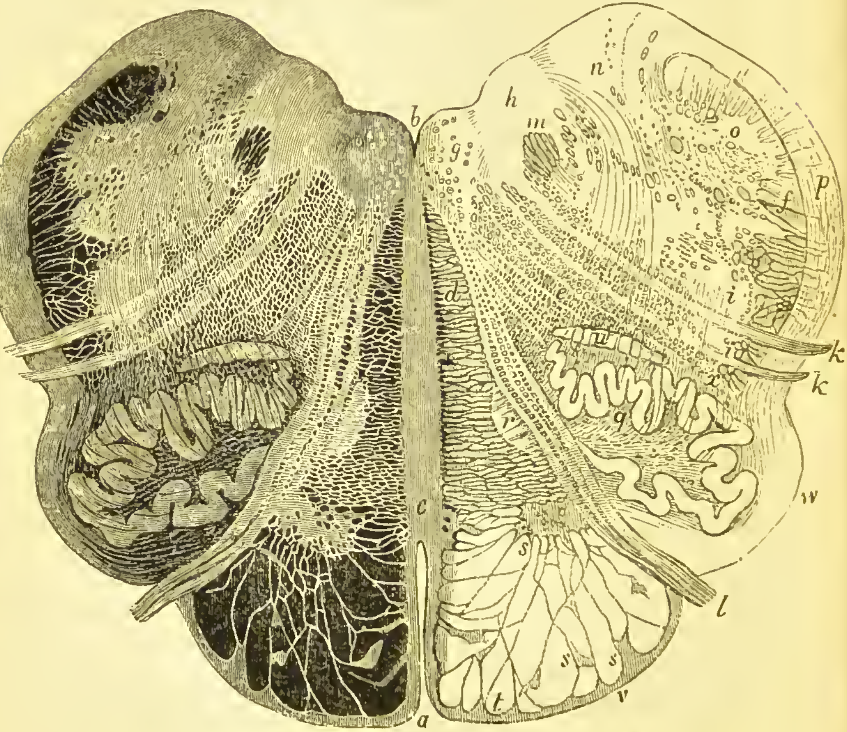
* Dr Reid *apud* Mr Solly. *Op. cit.*, p. 240.

olivary body in the human subject; for it was found by Schr. V. der Kolk to be invariably in connection with

Fig. 21.



Transverse section of the human *medulla oblongata*, through the lower third of the *corpora olivaria*. (From Stilling.)—*a*, Anterior fissure; *b*, posterior; *c*, raphe; *d*, anterior columns; *e*, lateral columns; *f*, posterior columns; *g*, nucleus of the hypoglossal nerve; *h*, nucleus of the vagus; *i i*, tubercle of Rolando; *k k*, roots of the vagus; *l*, hypoglossal nerve; *n*, post-pyramidal ganglion; *o*, restiform ganglion; *p*, transverse and arciform fibres (commissural medulla); *q*, olivary body; *r*, nucleus of pyramid, or anterior column; *s s*, small nuclei; *u*, accessory olivary body.

the hypoglossal nerve. The number does not seem to be necessarily limited to two, as Schr. V. der Kolk found three in the calf.*

987. The olivary bodies have been considered to be the

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* *On the Spinal Cord and Medulla Oblongata*, Transl. 172–6.

ganglia of speech by Willis, Dugès, Solly, and Pinel. Burdach, more correctly perhaps, regarded them as the centres of movements of both speech and expression. Schr. V. der Kolk seems to have proved by pathological observation that they are subservient to speech.* It is certain, however, that disease of the anterior lobes of the hemispheres, where they rest on the *os frontis*, will abolish the power of utterance; while, on the other hand, a person usually speechless under violent emotions may speak. A similar thing is observed with regard to laughter. A person with local disease cannot laugh voluntarily, but he can involuntarily. Hence, it is probable that the olivary bodies subserve to the expression of the emotions, through the muscles of the face and of the tongue, by language, and emotional cries or sounds. It is by no means improbable, however, that the emotional movements of the hands, as well as of the tongue and face, are likewise under their direction. They are therefore to be considered as regulative ganglia to the motor centres of the facial, hypoglossal, and limb nerves in the *medulla oblongata*, and as belonging to the pathemic substrata of the sensory tract (969).

988. The accessory olivary ganglia seem, however, to be more particularly the centres of *deglutition*. This is a highly complex process. The lower jaw, tongue, and *os hyoides*, as well as the pharynx, are all called into play. First the jaw has to be fixed; then the *os hyoides* elevated, and the glottis closed; then the tongue has to pass the food to the pharynx. These are for the most part spinal movements. Having reached the pharynx, the food is passed along by a mechanism almost, if not wholly, identical with that by which the contents of all hollow muscles are moved onwards, being wholly involuntary. Hence,

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* *Op. cit.*, p. 147, *sqq.*

this portion of the act is under the influence of the sympathetic.*

989. The cerebral organs situate within the *medulla oblongata* are intimately connected with a series of complex commissural structures, which have been termed generally the *arciform* fibres (fig. 17, *x*, and fig. 21, *p*). The relations of particular portions of these have not been determined, so as to bring them to bear on physiological or pathological phenomena. It is certain, however, that after entering into the most intimate connection with the various ganglia and the nuclei of the nerves in relation to them, they converge from every part to the raphe or thick white commissure of the *medulla oblongata*, and there decussate. One particular group (of antero-posterior fibres), which seems to connect the antero-lateral columns with the posterior, is very much increased at the summit of the medulla by considerable bands of fibrils, which, proceeding from the auditory ganglia, and decussating at acute angles as they enter the raphe, run down it parallel to their decussation. These, therefore, bring the sense of hearing into relation with the centres in the *medulla oblongata*. A deep layer of fibres, in close connection with the pyramidal and restiform ganglia, interlace with the roots of the vagus and glosso-pharyngeal nerves, and then with other fasciculi in connection with the sensory roots of the trifacial nerve.†

990. This elaborate system of commissures combines the ganglionic centres of the *medulla oblongata* into unity, while at the same time the relations of the dif-

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* Compare Schr. V. der Kolk's interesting discussion of this question, in his work already quoted, chap. viii. p. 180.

† Mr J. L. Clarke's "Researches," &c., *Phil. Trans.* 1858 pp. 250–51.

ferent parts to their own systems of organs and tissues is preserved. The muscles of the eyes, face, neck, tongue, and throat, are co-ordinated by the olivary ganglia; those of respiration by the respiratory tract; those of the trunk and limbs by the antero-lateral and motor columns. But when all these act together, as in a case of epilepsy, then the whole constitutes one co-ordinating centre, with functions like those which have been hitherto attributed to the cerebellum (972).

991. It is not surprising, therefore, that these anatomical and physiological facts have led inquirers to the conclusion, that the *medulla oblongata* is the seat of the morbid centric changes upon which epilepsy and other convulsive diseases depend. I need only refer on this point to the recent experimental researches of Dr Brown-Séquard,* Sch. V. der Kolk,† and Pflüger,‡ for facts in support of this doctrine. The influence on the *medulla oblongata* of the afferent branches of the 5th has been particularly shown by Dr Brown-Séquard, who ascertained that simply pinching gently the cheek of a guinea-pig, after partial division of the spinal cord, excited convulsions. If the one side of the spinal cord be cut through at any point between the 7th or 8th dorsal and the 3d lumbar vertebra, epileptic symptoms are manifested in about the third week after; so that a slight irritation of the cheek on the same as the injured side is sufficient to induce convulsions. These first show themselves in the muscles of the face and eyes; but as the morbid state advances, the muscles of the neck, larynx, and tongue, become involved, and finally those of the trunk and of respiration. On examination after death, congestion of

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* *Comptes Rendus* (1856), vol. xlii. p. 86.

† *On the Medulla Oblongata.* Transl. 1859.

‡ *Die Sensorisch. Funct. der Rückenmarks.* 1853.

the base of the brain, and of the Gasserian ganglia, is found,—either on one or both sides, according as the injury to the spinal cord had been inflicted on one or both sides. It thus, therefore, seems more than probable that the reflex hyperæsthesia and the epileptic attacks were due to morbid changes in the corporeal centres, the result of centripetal degeneration from the point of lesion (951).

992. The intimate connection of the roots of the trigeminus with the respiratory and pathemic substrata, and the fact that it is constituted of the afferent or cutaneous nerves which correspond to the *medulla oblongata* as a series of integrations of spinal segments, will suffice to explain all these facts. But there are facial differentiations of the sense of touch into nerves of special sense which have equally important relations to these convulsive phenomena, without any corresponding anatomical explanation. It is well known that particular sounds, odours, and colours, will excite convulsions, convulsive gasp, convulsive laughter, thirst, loathing,* &c. These must be operative as affinitive impressions upon the *medulla oblongata*, through the respective afferent nerves of vision, smell, and hearing; and an important question arises as to the route by which they reach the appropriate centres. A nucleus of the auditory nerve, we have seen (989), has been found in close relation with the nuclei of the respiratory nerves in the restiform tract,† and also with the nucleus of the facial;‡ and, at

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* See, for illustrative facts, my essay on "Hysteria," in *Edin. Med. and Surg. Jour.*, Oct. 1838, pp. 349–52, and July 1839, p. 20. Also my *Treatise on the Nervous Diseases of Women*, p. 340, *sqq.*, where I treat specially of "Chroöphobia." or "Chromatophobia."

† J. L. Clarke. *Op. cit.*, p. 250.

‡ Sch. V. der Kolk. *Op. cit.*, pp. 122–24.

the same time, the nerve is connected through its own nucleus with the restiform ganglion and the cerebellum, by means of fibrils derived from these structures; it even appears that some of the fibrils of the auditory nerve itself pass into the cerebellum. It has also a remarkably close connection with the trifacial nerve. These facts will help to explain how sounds affect the *medulla oblongata.*

993. Nothing of this kind, however, has been made out with regard to the olfactory and optic nerves. The olfactory nerve-fibrils, collecting from all parts of the nasal periphery, enter into the olfactory bulb or ganglion (A, fig. 23), from whence a commissure passes to divide into three branches (*a*, *r*, fig. 23), at the posterior, inner, and inferior part of the anterior lobes of the hemispheres. From this point, no direct anatomical connection between it and the *medulla oblongata* has yet been traced, although probably the improved methods of research now available may detect it. The optic nerves are still more complex in their relations. Commencing at the retina, they pass backwards (*b b*, figs. 22, 23), to unite and decussate at the *chiasma* or decussation. Thence two flattened bands of fibres, termed the *tractus opticus*, pass on to each lateral half (*c*, figs. 22, 23). This runs along the margin of the *tuber cinereum* (a ganglionic mass of cells—I, fig. 22; *a*, fig. 23), with which it is connected by a few fibrils, and then winds round the *crus cerebri.* Tho external margin is here connected by fibres with the under part of the middle lobe of the hemispheres. On reaching the posterior part of the *crus*, the *tractus opticus* divides into four roots (J J, fig. 22), and becomes connected with very important structures. The external surface widens; the fibrils forming its internal margin pass into the *corpora geniculata*, the largest into the external one;

while other fibres, deeper seated, terminate in each of the *tubercula quadrigemina* (D, fig. 22). The superior portion of the *tractus opticus* is seen to wind round the posterior extremity of the *thalamus* (J J). One portion, spreading on its superior surface, becomes intimately connected with it; while another portion, which subdivides, passes deeply into the substance of the *thalamus** (fig. 22, K). It is probable that a careful microscopic examination of these structures will show that visual affinitive impressions can reach the *medulla oblongata* from them along the olivary column (983, and *o t*, figs. 20, 22).†

994. These *tubercula quadrigemina* have been considered the ganglia proper of the optic nerves, and an ingenious but wholly untenable hypothesis founded thereon. In virtue of that hypothesis they have been classed with the olfactory bulbs, with which they have only one thing in common—viz., that they are both ganglionic; otherwise, the structure and relative functions of the two wholly differ. Hence also they have been termed the "optic lobes." Doubtless the optic tract is in connection with them; but then it is even more intimately connected with the optic *thalamus* and *corpora geniculata*. Section

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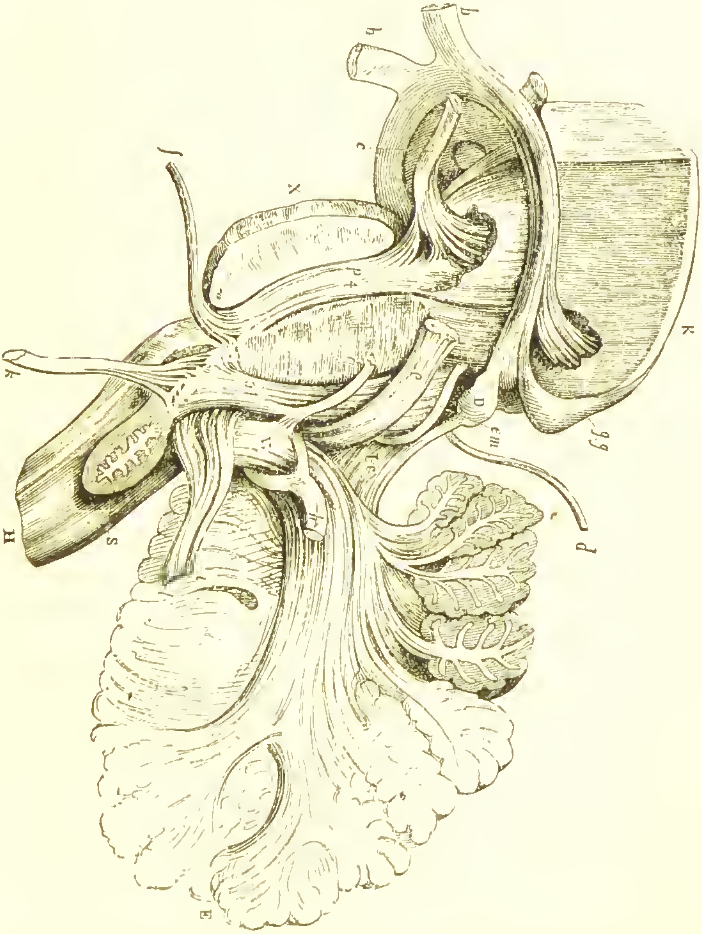
* Mr Solly. *On the Human Brain*, 2d edit. p. 292.

† I have given the ordinary anatomy of the optic tract and its connections, but I must not omit to state that M. Gratiolet has made some observations on the distribution of the optic nerve, which, if confirmed, will prove of great importance. He finds that the external band of fibres coming from the *tractus opticus*. and directed to the *corpus geniculatum externum*, does not enter that body, but passes on to the summit of the occipital point in the hemispheres. The internal band penetrates the *thalamus*, and its fibrils surround the central grey matter therein; both these contain numerous nerve-cells. The band which goes to the *tubercula quadrigemina* gives off from its external margin a bundle of fibres, which radiate in a fan-like manner into all parts of the hemispheres. (*Anatom. Comp. du Système Nerveux*. tom. ii. p. 180, *sqq.*)

of the optic lobes, it is said, makes animals blind. This is probable enough; but then it is inconceivable that

Fig. 22.



Shows the connection of all the cerebral nerves except the olfactory. (After Solly.) *b b*, Optic nerves joining to form the chiasma; *c*, *tractus opticus*; c . . . *oculo-motor*, or 3d nerve; *d*, 4th motor of the eye (of the oblique muscle of the globe); *e*, sensory root, and *e m*, motor root, of 5th; *f*, 6th, a motor nerve of the eye (of the abductor of the globe): *g*, 7th or motor nerve of the facial muscles; *h*, 8th, or auditory nerve, with its two trunks enclosing the restiform body;

i l, glosso-pharyngeal and vagus passing into the restiform body; *k*, lingual nerve; K, optic *thalamus*, divided and receiving fibres of the optic tract; J J, just below these letters, the *corpus geniculatum externum*, likewise receiving optic fibrils; D, posterior quadrigeminal tubercle, receiving optic fibrils; I *c*, cerebro-cerebellar commissure, to E, the cerebellum; H, spinal cord; S, olivary body; *o t*, olivary tract to tubercles; W, restiform strands to cerebellum; X, *pons Varolii; p t*, tract of the anterior columns or pyramids of the spinal cord passing upwards to the hemispheres.

such an operation could be performed without injury to all the connections of the optic tract. Pathological researches lead to widely different conclusions. In diseases of the optic nerve itself, causing blindness, the optic *thalamus* has been found atrophied after death, according to the law of centripetal dynamization (952); but the optic lobes remained unaffected.* Further, in the mole with rudimentary optic nerves, and which certainly are seldom used, the *tubercula quadrigemina* are of immense size. This fact is of itself sufficient to disprove the hypothesis as to the functions of these bodies referred to.

995. Now, it is far more probable that the *tubercula quadrigemina* belong to the *medulla oblongata*. As such they may be considered to be the co-ordinating structures for the substrata of the muscles of the special senses, including touch. In the use of what may be termed the three air-senses, various muscles have to be combined in action. Thus, in looking, listening, or smelling, the head of the animal is moved in all directions. In like manner, scents, sounds, and visual objects, determine the direction which the whole body shall take through space. The function of the auditory nerve in relation to the muscles of the head and trunk has been shown by the experiments of

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* A man had melanotic cancer of the right eye. Four years after extirpation of it he died. The right optic nerve was found to be flatter and smaller than the left; the right optic *thalamus* flatter; the *tubercula quadrigemina* normal. (Professor Virchow, in *Arch. für Physiol.*, vol. i. p. 473.) Several such cases are on record.

Flourens, who found that section of the semicircular canals produced in rabbits and pigeons jerking and other movements of the head; or the animals threw "somersets," or rotated on their axis. So also Dr Todd found, that when a current from a magneto-electric machine was transmitted through the *mesocephale* and *corpora quadrigemina*, the combined movements of flexion and extension, contraction and relaxation, affected all the muscles of the trunk and limbs.*

996. It seems probable, however, that the cerebral nerves of vision, hearing, and smell, are highly differentiated, and that what we call a single nerve is really compound. Thus, the optic nerve may subserve to at least three differentiations—namely, form, colour, and as a nerve of touch simply. The defect termed Colour Blindness has been much discussed, and the conclusion has been that it is probably due to cerebral defect. But there are reasons for the opinion that it may originate in imperfect action of chromatic nerve-fibrils. Thus in birds the retina rods are surmounted by globules of a ruby red or yellow colour. A structure of this kind would modify the coloured ray; and probably in all animals something of a chromatic nerve-structure will be found. Such an arrangement would explain the pathological influence of particular colours, especially of red, blue, and black, and also the phenomena of colour-blindness. It would also explain the numerous instinctive phenomena in relation to colour manifested by lower animals. This idea of a differentiation of the cerebral nerves leads to the further conclusion that what are termed their roots are really bundles of fibrils with distinct functions. What an enormous difference, in relation to nerve-centres, must there be between the optic nerve of an annelid or an

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* *Lond. Med. Gazette*, May 1849, p. 821.

insect and a fish, in which the sense of vision guides the instinctive movements of the animal, and in man, in which, through reading, writing, and the fine and mechanical arts generally, it is in relation with the highest evolution of the organs of the intellect and the sentiments! So also with the auditory nerve. Of all this class of anatomical relations of the cerebral nerves, we are as yet wholly ignorant. No hypothesis is even possible on purely anatomical data, so that speculation is simply useless.

997. All recent researches tend to the conclusion, that the old doctrine as to the common sensory is the correct doctrine (583), and that the *medulla oblongata*, as the ultimate point of insertion of the cerebral nerves as well as of the sensory nerves of the body, is at least the seat of the corporeal feeling of pleasure or pain. It is probable, however, that a series of changes has to take place in the great encephalic centres which end finally in the *medulla oblongata*, before the higher feelings and sentiments can be experienced. It is true, nevertheless, of the *medulla oblongata*, as of all parts of the cerebro-spinal axis, that adapted movements will result from changes therein which are wholly independent of sensation or consciousness. Thus, being the seat of the substrata of all those corporeal actions, cries, and facial movements by which states of consciousness are manifested, these can be, and are, manifested automatically. Hence the violent twitches of the face in infantile convulsions and epilepsy; hence also the automatic expression of suffering when no pain is experienced, as in automatic groaning (762), and in the scream which sometimes immediately precedes an epileptic paroxysm.*

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* This doctrine of the automatic character of certain pathological cries was advanced by me fifteen years ago (Letter in *Lancet*,

998. Those who are accustomed to associate consciousness with all adapted movements, cannot easily comprehend the automatic nature of such acts as these, and are therefore wholly incredulous as to the facts. Upon that point, nothing can satisfy them except their own observation. There are phenomena, however, in favour of the doctrine that the *medulla oblongata* is the common sensory of *all* conscious states,—whether they refer to corporeal processes, or the purely encephalic changes associated with ideas. The cerebral and cerebellar hemispheres may be considered as extensive peripheries, having, like the corporeal periphery, the *medulla oblongata* for their centre. So that teleorganic changes taking place therein, which in the usual states coincide with conscious states, as ideas, feelings, or desires, may, during morbid states, pass downwards to the *medulla oblongata*, and there excite the activity of appropriate motor or kinetic substrata, without at the same time exciting any state of consciousness whatever. This is, in fact, what occurs in all cases of automatic or unconscious cerebral action (666). Possibly, it is in the *locus niger* we must look for this common sensory.

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vol. i. for 1845, p. 347). Since then it has had abundant confirmation. Persons under the influence of chloroform have been known to hear themselves shriek during the performance of a surgical operation, at the very moment when they had no feeling of pain whatever. The vivisections of Brown-Séquard (*Comptes Rendus*, vol. xix. p. 672), and of Szokalski (quoted by Sch. Van der Kolk, *op. cit.*, p. 99), show that these cries may be excited independently of pain, by the reflex action of the *medulla oblongata*. They do not differ in their seat and origin from laughter, which, as I have shown elsewhere, occurs not only as a reflex act with consciousness, but also unconsciously (*Edin. Med. and Surg. Jour.*, July 1839, p. 19; and *Treatise on the Nervous Diseases of Women* (1840), p. 104).

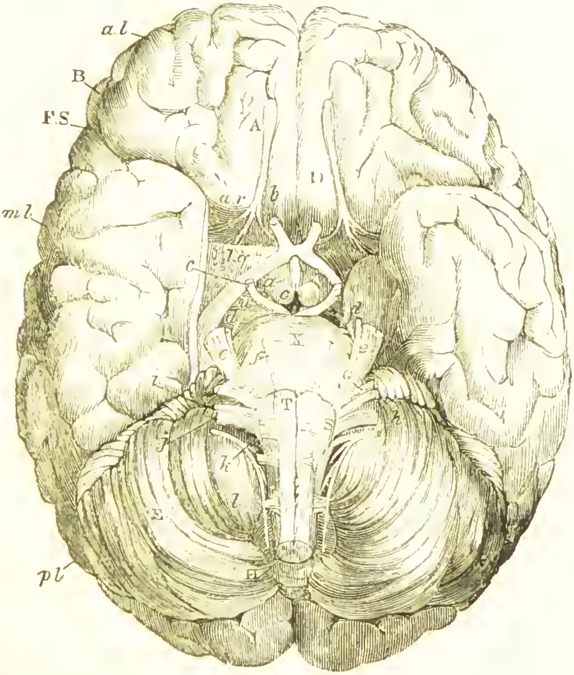
CHAPTER VII.

THE ORGANOLOGY OF THE BRAIN AND CEREBELLUM.

999. THE anatomy and physiology of the encephalon are most imperfect, and by no means warrant the positive theories as to the functions of its different portions which are so confidently yet so hastily put forth. Little is known definitely as to the uses of the cerebellum; still less as to the use of minor structures at the base of the brain. All other important organs, through which a large quantity of blood freely circulates, have their blood-glands, or lymphatics. Few care to inquire how the encephalon is supplied with them, or even whether such structures exist; to many, the mere idea that the *pia-mater*, or some of its processes, have a function of this kind (as they *possibly* have), will be wholly novel. Under these circumstances, to indulge in minute speculations as to the structure, connections, and functions of all parts of the encephalon, would be worse than useless. I shall therefore only take a broad general view of the subject.

When the human brain is removed and turned up, the connection of the encephalon with the body, through the nerves and the spinal cord, becomes manifest, and a complicated series of structures is presented to view (fig. 23). The cerebral nerves, we have seen, are connected either directly or indirectly with the *medulla oblongata;* we have now to follow the parts of that centre upwards into the cerebellum and the hemispheres; the former being posterior, the latter anterior.

Fig. 23.



Description.—Base of the Encephalon. A portion of the middle lobe of the left hemisphere has been removed, to show the *tractus opticus* and *crus cerebri.*

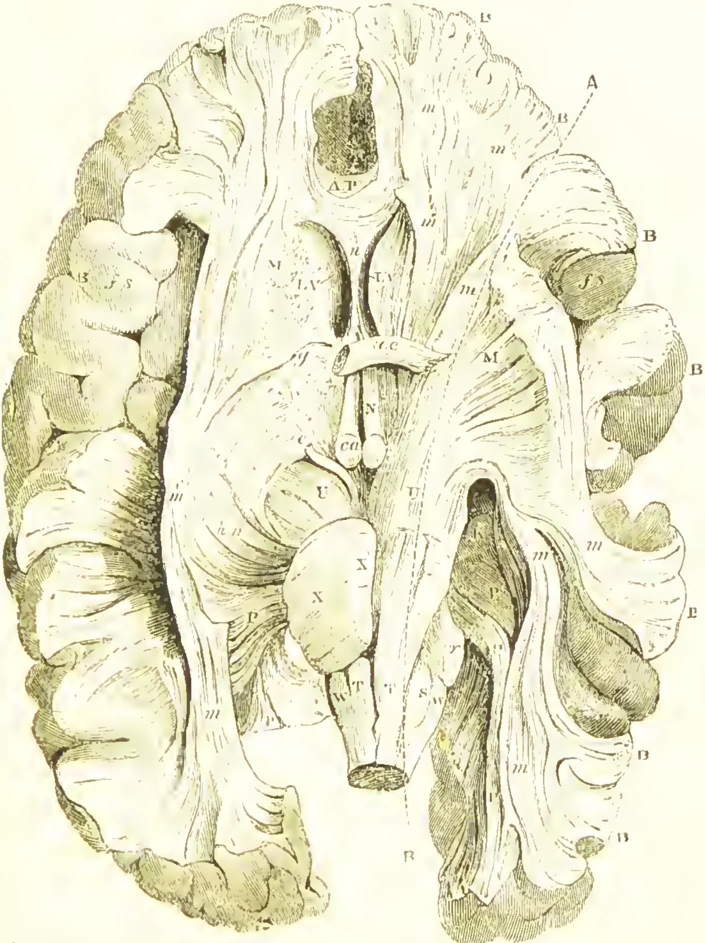
A, Olfactory ganglion; *a r*, the three divisions of the olfactory commissure; *b*, optic nerve; *l q*, *locus quadratus* (centre of the anterior convolutions); *c*, *corpora albicantia*—the white line above is the infundibulum; *a*, *tuber cinereum*; *c*, 3d pair of nerves; *d*, 4th pair; *e*, 5th; *f*, 6th; *g*, 7th, or facial; *h*, 8th (auditory); *i*, 9th, or glosso-pharyngeal; *j*, 10th, or pneumogastric; *k*, 11th, or lingual; *l*, 12th, or spinal accessory; B, hemispheres; D, orbital convolution; *a l*, anterior lobe; *m l*, middle lobe; *p l*, posterior lobe; E, cerebellum; H, spinal cord; S, olivary body; T, anterior columns or pyramids; *u*, *crus cerebri*; X, *pons Varolii*; F S, *fissura Sylvii.*

1000. We have already traced the anterior or volitional, and the posterior or sensory, columns of the spinal cord upwards into the *medulla oblongata*; and we have also determined that its pathemic centres, constituted of the sympathetic, intervertebral, and respiratory substrata, are finally evolved into the post-pyramidal and restiform ganglia. These are connected with the cerebellum (E, fig. 23) by means of a bilateral cord-like commissure, which I will designate, for brevity's sake, the restiform commissure. It manifestly brings the *medulla oblongata* into the closest co-ordination with the cerebellum (964). The antero-lateral and anterior columns (T, fig. 23), together with the posterior columns, pass forward towards the hemispheres, through a highly commissural structure, the *pons Varolii*.

1001. The *pons Varolii* is the most central point in the whole nervous system (957, 982). Here commissural cord-like tracts in connection with the hemispheres of the cerebrum and cerebellum (termed *crura*) meet with the *medulla oblongata*. It is thus of a most complex structure. Since it contains in its posterior division, where the fibres in connection with the *medulla oblongata* traverse it, a large quantity of vesicular neurine, or grey matter, it is obviously a ganglionic commissure of great importance as to its relations. It is otherwise made up of longitudinal and transverse fibres. The transverse (X X, fig. 24) constitute the great transverse commissure of the cerebellum, and bring its co-ordinated bilateral convolutions into connection with other commissural structures in close union with this centre, through the two large cord-like bundles of fibres extending to each hemisphere, termed the *crura cerebelli* (X X, fig. 24). Behind this commissure, the pyramids, or supposed continuation of the anterior or volitional columns of the spinal cord, extend successively through the *pons*, the *crura cerebri* (U U, fig. 24), the *corpora striata* M M, and thence, *m m m m*, into the convolutions B B B of the hemispheres.

1002. The posterior column, or supposed sensory tract of the spinal cord, ascends through the posterior part of the *pons Varolii*, decussating (before it enters) with that of the opposite side (fig. 25, D S). Emerging from be-

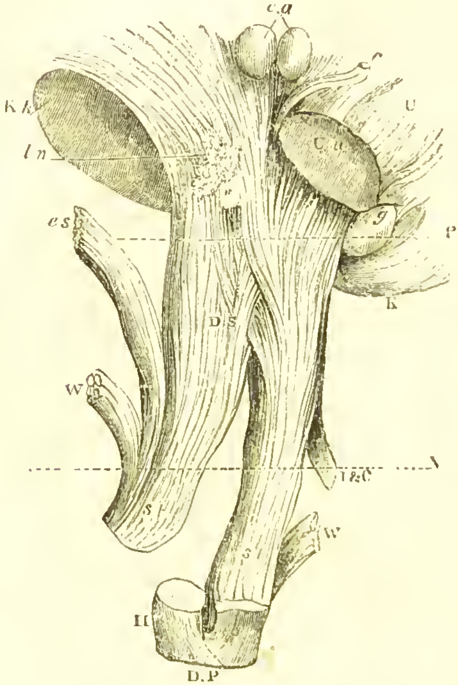
Fig. 24.



Course of the motor tract. (Solly.) B B B, Convoluted surface of the brain; K, divided *thalamus*; *n*, *septum lucidum*, dividing the anterior cornua of L.V, L.V, the lateral ventricles; M M, *corpora striata*; *m m m*, fibres passing between them and the hemispheres; N, anterior portion of the inferior longitudinal commissure of the hemispheres (*fornix*), ending in *c a*, the *corpora albicantia*; A P, anterior, and P P, posterior extremity of the transverse commissure of the hemispheres, or *corpus callosum*; S, olivary body; T, pyramids; U U, *crura cerebri*; W W, restiform body.

hind the *pons*, it forms the upper part of the *crus cerebri;* a deposit of grey matter, termed the *locus niger*, the use of which has been surmised (998), separates it in the *crus* from the motor tract. Here it is covered by the optic tubercles and the cerebro-cerebellar commissure. From this point the fibres are continuous into the *thalamus*, from which it is believed they pass, fan-like, into the convolutions of the hemispheres.

Fig. 25.



Course of the sensory tract of the spinal cord or posterior third of the antero-lateral column (after Solly). The pyramidal and olivary bodies are removed to show the sensory tract. D P, Decussation of the anterior pyramids; *s t*, sensory tract; D S, decussation of the sensory tract; *c s*, sensory *root* of 5th; *l n*, *locus niger*; K, posterior extremity of *thalamus*; K *k*, divided end of the *thalamus*; *c a*, *corpora albicantia*; *c*, motor-ocular, or third pair of nerves: U, *crus cerebri*; U *u*, its divided end; *g*, *corpus geniculatum externum*; I & C, cerebro-cerebellar commissure; W W, restiform commissure.

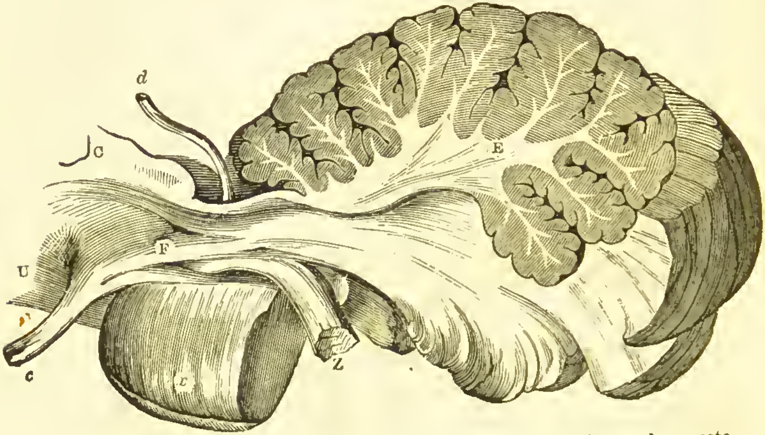
1003. These connections are those of the brain and spinal axis exclusively. It is now necessary to examine the connections of the cerebellum. These are threefold. First, with the pathemic tract of the *medulla oblongata* through the restiform bodies (964): secondly, with the anterior motor and sensory columns of the spinal cord in the *pons Varolii;* and thirdly, with the *thalami* and *corpora quadrigemina*.

1004. The restiform commissure (fig. 22, w *f*.) passes into the cerebellum, in which its fibres are more especially distributed to the two vermiform processes and the posterior laminæ of the lateral lobes. The vermiform process is the most elementary portion of the cerebellum; it is the first formed, and is found in the lowest stages of development of the nervous system in vertebrates.

1005. A bilateral commissure in the form of two thick cords passes to the cerebrum from the cerebellum—the "*processus è cerebello ad testes*," or cerebro-cerebellar commissure (I and C, fig. 20). Mr Solly divides its fibres into three classes: *first*, those which pass between the optic tubercles and the cerebellum; *secondly*, fibres which may be traced to the side of the tubercles, and thence to the optic *thalamus*. These, Mr Solly thinks, pass through the *thalamus* into the hemispheres. And, *thirdly*, a set of fibres which appear to connect the preceding structures with the sensory tract, and to belong, in fact, to the optic centres. There are fibres which Mr Solly found to descend and interlace with the ascending fibres of the sensory tract. They may be traced through the *locus niger* (fig. 25, *l n*), until they become continuous with the motor tract and that portion of the fornix connected with this point. Both this and the restiform commissure are in intimate connection with a ganglion, termed the *corpus dentatum*, situate in the cerebellum, a little on each side of the mesial line, very near the centre, and which is exactly similar in appearance to the olivary body (fig. 30, *e*).

1006. Mr Solly has described another set of commissural fibres, which seem to connect the cerebellum more especially with the anterior columns and motor tracts of the olivary ganglia. These are a superficial set of fibres stretching from the olivary bodies into the anterior columns, and from thence entering with the restiform commissures into the cerebellum.* If this commissural

Fig. 26.



The cerebro-cerebellar commissure. (After Solly.) C, Anterior, and D, posterior tubercle; I and C, commissural fibres between them and E, the cerebellum; F, descending fibres from the tubercles to the motor tract of *medulla oblongata;* U, *crus cerebri;* *x*, *pons Varolii;* Z, restiform commissure and olivary column divided; *c*, 3d pair of nerves; *d*, 4th pair; *e*, motor portion of 5th.

connection be confirmed, it indicates a distinct route, whereby the cerebellum is brought into relation with the organs of speech, and the motor substrata generally of the spinal cord. The subjoined is Mr Solly's delineation of this commissure (fig. 27).

1007. *Functions of the Cerebellum.*—We may now deduce from the numerous facts already advanced a satisfactory hypothesis as to the functions of the cerebellum. And in the first place, seeing that through the restiform commissures (964, 969) it is in the most direct connection with the pathemic substrata of the cephalo-spinal axis, we must conclude that it has a central regulative function with respect to them. Now, the facts of embryological anatomy, and the general doctrines of development, both tend to show that the cerebellum is a differentiation of that portion of the *medulla oblongata* with

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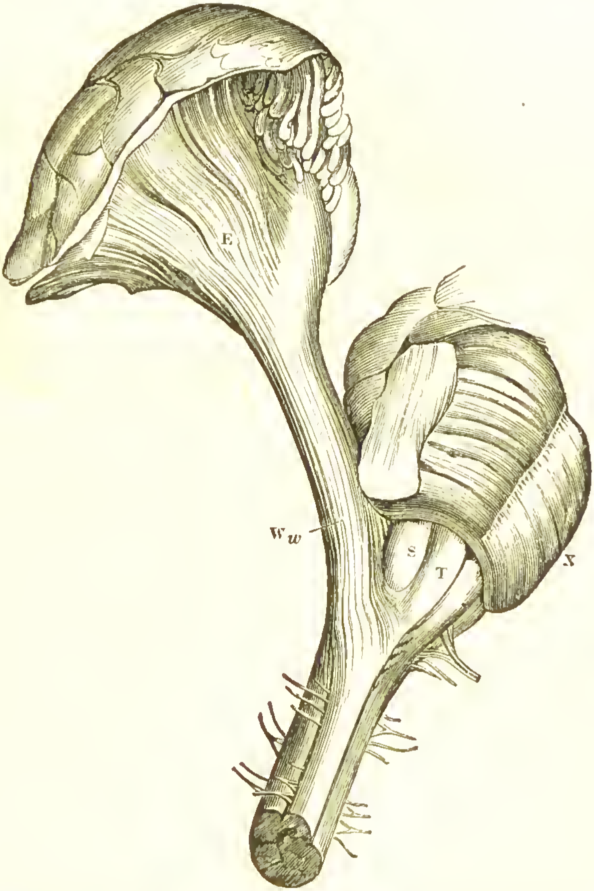
* *Phil. Trans.* 1836; and *On the Human Brain*, 2d edit., p. 226.

Fig. 27.



Commissural connecting the cerebellum with the olivary bodies and columns. (After Solly.) E, Cerebellum; X, *pons Varolii;* T, anterior pyramids; S, olivary body; W *w*, restiform commissure (its surface scraped, to show the course of the fibres to the pyramids).

which, through the cerebro-cerebellar and restiform commissures, it is in immediate relation. In the lowest vertebrates (as the lamprey), the cerebellum is simply a lamina of grey matter attached to the optic tubercles and *medulla oblongata*. The former, with their connections, are developed anteriorly, both to the hemispheres of the cerebrum and cerebellum; these may therefore be looked upon as differentiations of the *tubercula quadrigemina* and *thalami*. But the more immediate evolutional connection of the cerebellum and the posterior lobes with the *medulla oblongata*, is shown by the fact that both derive their supply of blood through the same arterial system as the spinal cord (the vertebral system), while the brain is supplied from the facial, or carotid system. From this we may infer that the cerebellum is a differentiation of the intervertebral system.*

1008. We may thus conclude, therefore, that while the hemispheres and their subservient ganglia are the organs of external relation proper, the cerebellum presides over all those vital processes which are involved in co-ordinated visceral function, and in the relations of the blood to the viscera and nerve-centres generally (662 *sqq.*, 681 *sqq.*) It is the centre of vegetative life, and of all the processes of the organic appetites and instincts. Its convolutions may be considered from this point of view as a periphery from whence an infinite variety of *internal* afferent changes are co-ordinated and reflected upon the hemispheres; it is therefore a portion of the great afferent or sensory tract—not, however, in *direct* relation with the periphery, either internal or external, but with indirect relation, through the sympathetic and invertebral systems, and their co-ordinating structures in the spinal cord and *medulla oblongata* (964).

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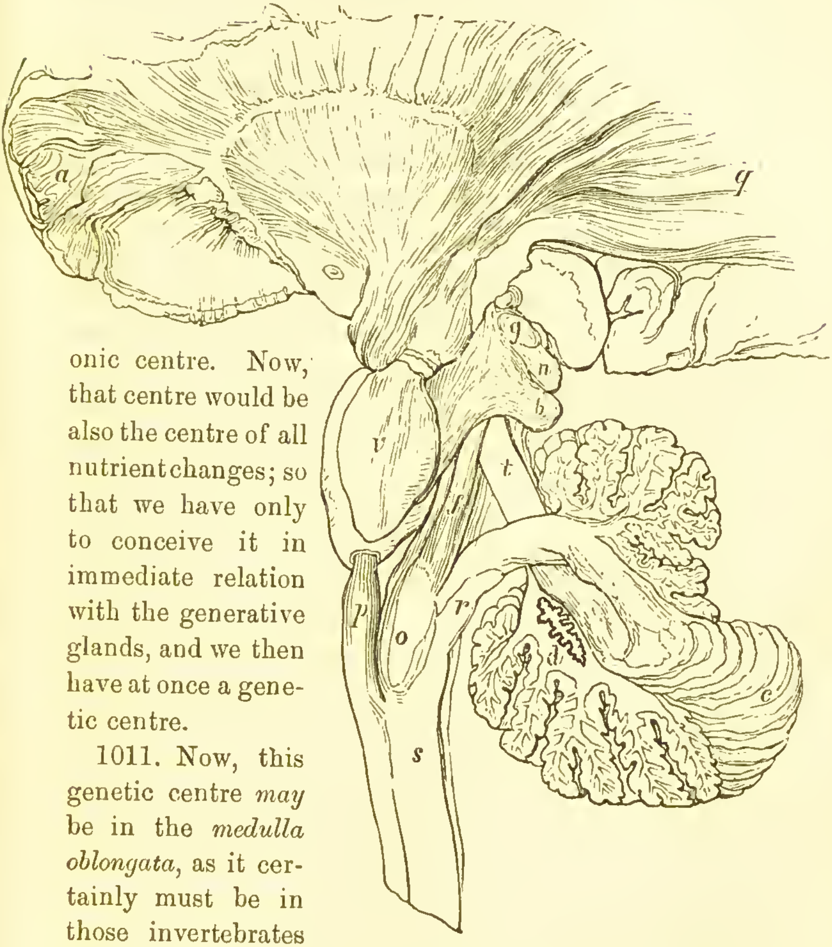
* The relations of arterial development to centric evolution of the nervous system have been worked out by Serres in his *Anatomie Comparé du Cerveau*. The value of these relations in the determination of the connections and functional relations of the nerve-centres, has not hitherto been appreciated by systematic writers. Parts supplied by the same arterial system are most probably supplied by the same vaso-motor system.

1009. From this point of view, the cerebellum must be the final centre of those afferent impressions which functional changes in the ovaria and testes, in common, however, with other viscera, develop in the nervous system; consequently it is in and by teleorganic changes, occurring primarily in the cerebellum, that the cerebral organs of the propensities, sentiments, and faculties, are excited into activity under the influence of the generative glands (518–520, 684). But to this end there is an ever-increasing evolution of function and differentiation of structure. First, the affinitive impressions act on the sympathetic ganglia and plexuses, and their spinal substrata (963); then they pass on to those of the *medulla oblongata* (*o*, fig. 28; 964, 965); from thence, along the restiform commissures (*r*, fig. 28), to the vermiform processes of the cerebellum. From hence there may be three routes for the transeunt *vis nervosa*. One may be along the cerebro-cerebellar commissures (*t*, fig. 28) to the *thalami* and *tubercula quadrigemina* (*n b*). This, however, is more probably a route for transeunt *vis nervosa* passing in the opposite direction to the cerebellum, from these structures, as differentiations of the *medulla oblongata* (995), and possibly even from the hemispheres themselves. Another route may be downwards along the olivary commissure (983, and *f*, fig. 28) to the *medulla oblongata*, or along Solly's descending fibres of the cerebro-cerebellar commissure (F, fig. 26), which interlace with fibres of the sensory tract ascending to the brain (1005). The third route may be back from the vermiform processes, along the fibres in the restiform commissures, which Mr Solly found to proceed to the anterior or motor columns and the olivary ganglia (E, fig. 27). These, however, may more properly be considered as bringing the cerebellum into relation with the regulative substrata of the muscles of expression (987), and perhaps with the entire *medulla oblongata* as one centre (990). Now, as all the pathemic phenomena become objects of consciousness, the results of the downward action of the cerebellum, manifested in the peripheral organs, will be felt, and transmitted back again, along the spinal sensory tract, to the hemispheres. In this way an entire corporeal circle of teleorganic changes will be completed, in which emotional phenomena end either in the concurrence of the will, or in the non-concurrence. It is to be remembered, in considering this explanation, that affinitive impressions reach the cerebellum through the centres of the cerebral nerves,—as appears certain as to the auditory (992), and probable as to the olfactory and optic nerves (993); and that, like all ganglia of its class, its commissures may contain both afferent and efferent fibrils.

1010. This view of the functions and relations of the cerebellum enables us also to understand how it may be the seat of that unifying corporeal function in virtue of which the genetic cells contain potentially all the corporeal and mental potentialities of the individual (291). The internal impressions, coming as a *vis nervosa* from every vessel and gland to the cerebellum, and passing thence to the vast expanse of the hemispherical ganglia, cause definite changes, according to the character of the substrata excited to action; but these are in their turn reflected upon the cerebellar hemispheres on the one side, and back again, through the *medulla oblongata*, upon the viscera and tissues in general on the other. In any case, the teleorganic changes induced in the cerebellum must be unified to produce an instinctive desire, emotion, or passion with its acts; and to this end there must be a unifying or gangli-

Fig. 28.



(After Mayo.) Shows the commissures of the cerebellum, and the connection of the principal elements of the encephalon. *a*, Anterior lobes of brain; *s*, spinal cord; *r*, restiform commissure; *t*, cerebro-cerebellar commissure; *c*, cerebellum; *o*, olivary body; *f*, olivary commissure; *v*, *pons Varolii*; *n*, anterior, and *b*, posterior *corpora quadrigemina*; *g*, *corpus geniculatum externum*.

onic centre. Now, that centre would be also the centre of all nutrient changes; so that we have only to conceive it in immediate relation with the generative glands, and we then have at once a genetic centre.

1011. Now, this genetic centre *may* be in the *medulla oblongata*, as it certainly must be in those invertebrates which have nothing more; but in man and the Vertebrata generally, with their highly individualised organism, it seems more in accordance with general laws to look for it in the cerebellum; and the *corpus dentatum* may be the genetic centre, for it is the most central ganglionic mass of the cerebellum, and has special connections as well with the *medulla oblongata*, through the restiform commissures, as with the cerebro-cerebellar commissures in which it is embedded (fig. 30, *e*). Or it may be found in the vermiform processes and lateral laminæ, as the commissural connections of the brain and *medulla oblongata* with these are most intimate.*

1012. It is hardly necessary to refer to the well-known facts of phrenology, or to the vivisections of Budge and others, which decisively prove the intimate connection between the cerebellum and the generative glands and abdominal viscera; or to the results of the experiments of C. Bernard and others, as to the influence of the restiform strands on the secretions, and especially on the production of sugar in the liver and the blood. All these are now well-known facts.† It is obvious from these considerations that there must be a much closer relation between the cerebrum, cerebellum, and viscera, than has been hitherto suspected, and that it is probable microscopic researches will detect changes in the one correlative with changes in the other.

1013. Willis entertained views very similar to those just advanced; but he founded his doctrines mainly on the facts of comparative anatomy. He observed that the development of the *pons Varolii* bore a relation to the complexity of the passions and emotions. In man it is large; in the calf, sheep, goat, hare, "and other milder animals," he found it to be very small. Next to man, this part, he says, is greatest in a dog, cat, fox.

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* Compare Mr Solly. *The Human Brain*, 2d edit. p. 273.

† Budge found that irritation of the cerebellum excited motion

1014. The nature and cause of a great variety of pathological states may be explained by this doctrine of the functions of the cerebellum. Amongst others, I may mention a curious class of hyperæsthesiæ of the viscera and muscles, as distinct from those of the skin and external senses, which accompany epilepsy, hypochondriasis, and melancholia, when the results of excessive gratification of the sexual *orexis*, either naturally or contranaturally. Several such cases have come under my notice, in which purely *internal* hyperæsthetic sensations of an indescribable character were experienced.

1015. *Functions of the Hemispheres.*—The hemispheres are first developed anteriorly in relation with the *corpora striata* and *tubercula quadrigemina*. They seem to be primarily a simple lamina of ganglionic tissue, in which the special afferent impressions of external relation are reflected in appropriate substrata upon the motor and regulative centres of the *medulla oblongata* (including the optic lobes), so that the movements of the entire animal in relation to external things may be unified. This process is fundamentally one of automatic indefiniteness, or congruity and incongruity of the afferent impressions (462) to be evolved into coincident conscious states under a suitable differentiation of the tissue. It is nothing

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of the stomach, and that the testis on the same side as that on which the cerebellum was irritated was raised so that the spermatic cord formed nearly a right angle with itself. The uterus, Fallopian tubes, and *vas deferens*, manifested a similar relation with the cerebellum. Other facts of a like bearing are mentioned in reference to the connection of the large and small intestines with this organ and the adjoining *corpora quadrigemina* and *corpora striata*. (*Untersuchungen über das Nerven System.* Von Dr Julius Budge, 8vo, 1841–42.) Compare also Mr Combe's Translation of Gall, Vimont, and Broussais, on the Functions of the Cerebellum, Edin. 1838, for numerous facts.

more than a manifestation of that primary property of every living tissue in virtue of which it responds to affinitive impressions (413). Hence, the entire hemispheres may be looked upon as a differentiation of this elementary organ of comparison. The substrata of the hemispheres, like those of the olivary body and of the cerebellum, are regulative; they do not act directly upon the muscles, but upon the motor nerve-cells of the spinal cord in connection with the muscles. Those of each hemisphere are brought into close and intimate relation by two longitudinal commissures—the superior, and the inferior or *fornix* (fig. 24, N). The former seems to co-ordinate the higher convolutions more especially;* the latter seems to extend between the sensory centres—the *thalami*—and the convolutions at the base, so as to bring them into mutual relation. A very important commissure is that which co-ordinates the two hemispheres—the *corpus callosum*. It is a large mass of nerve-fibrils, the extremities of which are everywhere in contact with the internal or central surface of the cineritious layers which form the convolutions of the hemispheres, and unite the two extensive layers of neurine in common action. Fibrils in connection with every part of each hemisphere (*m m m*, fig. 24) traverse to, or diverge from, the *corpora striata*, M.M. Little, or rather nothing, is known as to the relations of these commissures to the six or seven strata of grey and white matter of which the convolutions are made up. Nor is anything known of the functions of these different strata. We may conclude *à priori*, first, that they have different functions, for this is the law as to distinct groups of layers or cells (774); and secondly, that they are probably alternate regulative or ideagenic, and kinetic or motor substrata. This would reduce the distinct functions of the layers to three—*i. e.*, two for each function.*

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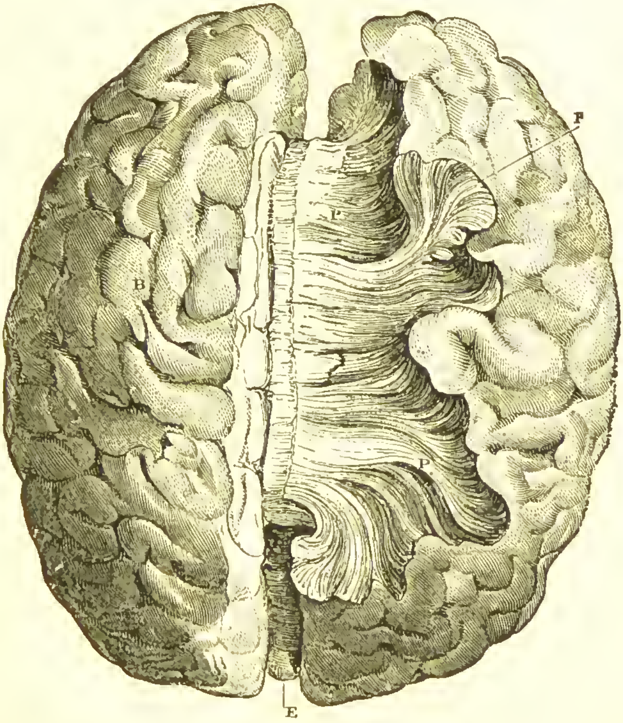
* Mr Solly. *On the Human Brain*, 2d edit. p. 253.

Fig. 29.



The course and connections of the great transverse commissure of the hemispheres. (After Solly). P P P, Fibres of the commissures radiating into the right hemispheres; B, left hemispheres, left undissected; E, cerebellum.

1016. The general connections of the hemispheres with the principal ganglionic centres of the encephalon are well shown in the subjoined cut from Mr Solly's work. The brain has been laid upon its upper surface, and a section made longitudinally through the *medulla oblongata, pons Varolii, cerebellum, corpus striatum*, optic *thalami*, the great transverse commissure, or *corpus callosum*,

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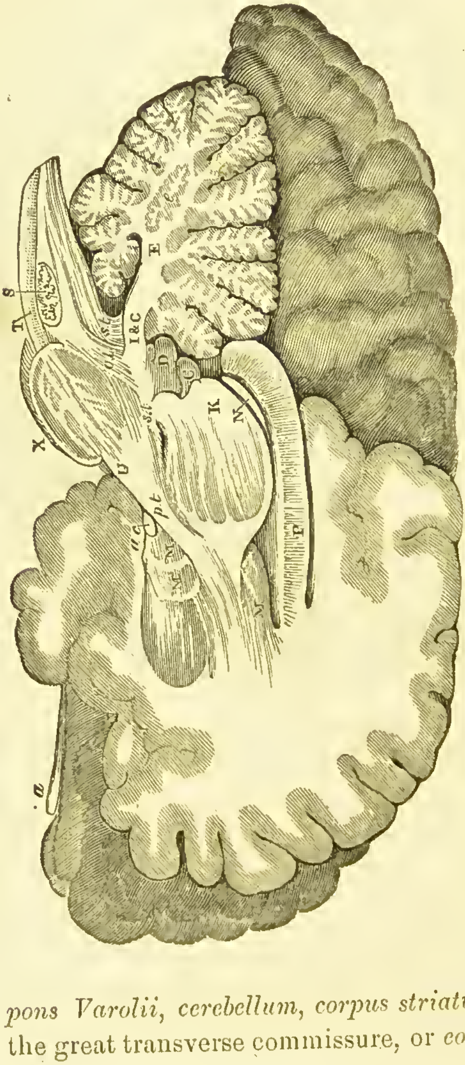
* M. Gratiolet states that he has discovered distinct laminæ in the *corpus callosum*, the arrangement of which is determined by the folds of the convolutions. It is not the same in all animals, but only in the same families. Thus, the laminæ have a similar arrangement in the lion and cat, the bear and the weasel, the chimpanzee and myopithecus. (*Anat. Comp. du Système Nerv.*, tom. ii. p. 178.)

Fig. 30.



Description.—*a*, Olfactory ganglion; E, cerebellum; *e*, *corpus dentatum* of cerebellum; S, olivary body of *medulla oblongata*; *s t*, *s t*, sensory tract; I & C, the commissure between the vermiform processes and *corpus dentatum* of the cerebellum on the one side, and D C the optic tubercles, and K the optic *thalamus*, on the other; N, *fornix*; F, *corpus callosum*; *a c*, anterior commissure; M M, *corpus striatum* receiving fibres from the hemispheres which pass along *p t*, the pyramidal tract, to U, the *crus cerebri* (a cord-like commissure); and thence through X, the *pons Varolii*, to end in T, the supposed head of the anterior motor columns of the spinal cord; *o l*, the olivary commissure with the optic lobes D C, and the *thalami*.

and the inferior longitudinal commissure or *fornix*, taking the direction of the dotted line A B, fig. 24.

1017. The organology of the convolutions has been made a subject of research by numerous anatomists and physiologists. That a minute cranioscopy, founded on the European type, is applicable to all races of men, may be well doubted; but all agree in admitting the validity of the great regional divisions of phrenology. Thus the middle region of the encephalon, whatever it may be (possibly the middle lobe), which corresponds to the central region of the head, of which the crown or centre of the hair is the focus, seems to be the seat of the egotistic faculties. Superiorly are the organs of the egotistic sentiments, inferiorly of the egotistic instincts and propensities (481). Posteriorly to this region is that of the sexual and domestic instincts and sentiments, in relation, by arterial connection, with the cerebellum (1007); anteriorly to it, the relative instincts and sentiments termed moral, and which are founded on the intuitions of truth and perfection, good and evil (510). In close relation with this group are the æsthetic faculties, founded on the intuitions of the beautiful (501); and finally, in front, are the organs of the faculties by which a knowledge of the order of phenomena, and of the modes of action of the physical forces, is attained. These are the faculties of observation, deduction, and induction, founded on intuitions of the forces (496–499). The size of the convolutions will depend in all cases on the complexity and number of the intuitions, the extent of corporeal differentiation, and the correlative external relations of the organism.

1018. As the development of the convolutions is from before backwards, it is probable that there is a continual evolution and differentiation of the anterior lobes backwards, and that they co-ordinate, as a fundamental function, all the substrata of the other convolutions; or, in other words, they are the central and unifying organs of the mind. It is in these convolutions that the kinetic and regulative substrata of the intellectual will are to be found (975). Thus, there seems to be no doubt that the kinetic substrata of language, as expressive of the thoughts, are in the anterior lobes which rest on the *os frontis.* A man in disease of the brain is not able to speak his thoughts, but he can read aloud, or repeat what is spoken to him (987). And as with speech, so also with all those actions by which the human hand represents ideas in material form, whether in painting, music, sculpture, or the constructive arts generally. It is in accordance with all the laws of development, that there are both kinetic and regulative substrata in connection with these faculties.

1019. The facial development appears to be in regional correspondence with the cranial development. The under lip and lower jaw are more especially developed concurrently with a preponderating evolution of the organic and war instincts (Part V., chap. vii.); their development, therefore, indicates in man both corporeal vigour and force of character. The upper lip and upper jaw correspond generally to the region of the domestic and relative instincts and sentiments; the nose, to the higher moral and æsthetical sentiments; and the eyebrows and forehead, to the region of the knowing and intellectual faculties. Although these empirical conclusions are obviously very general, and not of easy application to the diagnosis of individual character; and although, when thus explicitly stated, doubts may be excited as to their validity,—yet it is a matter of common experience that men do habitually use an instinctive physiogomical knowledge, of which these are the general principles (570).

1020. The infinite diversity of character and the resulting variety in the play of the vital forces modify the development of these fundamental forms of brain, cranium, and face, to an extent which has not yet been investigated, either ethnologically or specially, in a scientific spirit (575). A step of this kind, in the direction of human palæontology, has been made by M. l'Abbé Frère, Canon of the Cathedral of Paris, who has lately formed a collection of ancient skulls sent to him from all parts of Europe; and deduced, from a comparison of them, the general conclusion, that in proportion as the skull belongs to an ancient or primitive race, in the same proportion the frontal region is flattened and the occipital developed. Such a conclusion, if verified, would go far to establish the general law, that each of the successive generations of men adds something, however small, to the evolution of the human mind; and that, amidst all the struggle of races and the decay of inferior tribes, a higher and nobler type of humanity is more and more developed.

APPENDIX.

Examination of Dr Carpenter's Claim of Priority as to the Discovery of the Law of Unconscious Cerebral Action.

In the fifth edition of his *Principles of Human Physiology* (1855), Dr Carpenter expounds the doctrine taught in this work of unconscious vital action of the brain, as the organ of thought. He shows that "much of our highest mental activity is to be regarded as the expression of the *automatic* action of the cerebrum;" and that it "may act upon impressions transmitted to it, and may elaborate results such as we might have attained by the purposive direction of our minds to the subject, *without any consciousness* on our parts" (p. 607). "Looking," he adds, "at all those automatic operations by which results are evolved without any intentional direction of the mind to them, in the light of 'reflex' actions of the cerebrum, there is no more difficulty in comprehending that such reflex actions may proceed without our knowledge, so as to evolve *intellectual products* when their results are transmitted to the sensorium and are thus impressed on our consciousness, than there is in understanding that impressions may excite muscular movements through the reflex power of the spinal cord, without the necessary intervention of Sensation." He (Dr Carpenter) shows how his doctrine can be made to explain the etiology of the remarkable mental states induced by mesmeric, electro-biological, and similar processes, and how it elucidates the nature of delirium, somnambulism, insanity, and the like. He has designated this class of operations by the term "unconscious cerebration" (p. 609); and for all these views he sets up a formal claim of priority in the preface to this fifth edition of his *Human Physiology*.

This general law of cerebral action is, if true, of such fundamental importance to mental science, that, if the claim thus set up be at all credible, Dr Laycock has done Dr Carpenter great injustice in not giving it the fullest recognition in this work. Unfortunately, the claim is wholly unfounded; for the law was discovered and applied by Dr Laycock to mental physiology and pathology more than twenty years ago, under the term "reflex function of the brain," and twelve years before Dr Carpenter knew anything of it whatever. "Unconscious cerebration" is in fact only another phrase to designate reflex cerebral function.

It is necessary to state, however, that while Dr Carpenter has thus elaborated physiological doctrines identical with those of Dr Laycock in general principles and in details, he has commingled with them certain other theories of his own, for which Dr Laycock's doctrines are in no degree responsible. In these peculiar theories, the organic mechanism or organology is the main object of consideration, especially as to the so-called "sensori-motor" structures and functions; and the great principles of mental philosophy have little or no share. Now, although Dr Laycock has never expressly developed his method of inquiry, he has always followed that which is evolved in these pages, and which rests upon philosophy alone.

It will be seen from this, that the difference between Dr Carpenter and Dr Laycock as to principles is fundamental. The former believes, or believed, in the distinctness of "mind" and "vital principle;" his doctrines, therefore, are necessarily mechanico-vital;—the latter reduces mind and the vital principle to unity; his doctrines, therefore, are necessarily teleological. Consequently, while undertaking to show that Dr Carpenter's claim has no foundation in fact, Dr Laycock thinks it advisable to indicate the origin and modes of development of his doctrines.

In the year 1837, much interest was excited in London and elsewhere by the results of mesmeric manipulations upon two girls named O'Key, patients in University College Hospital. Various opinions were expressed by physiologists at that time as to the nature of these mental "mesmeric" phenomena. By the great majority they were looked upon as simply fraudulent; by a few they were thought to be manifestations of hysteria. Dr Laycock was at that time attached to the York County Hospital, and, after careful inquiry and experimental research, he came to the conclusion that they constituted a group of functional diseases of the encephalon, artificially induced: and that hysterical girls or women were the most susceptible of them. Desiring to solve the true nature of these states, he was led step by step to a special investigation of the phenomena of hysteria, and of the diseases of the nervous system of women generally, and which was conducted both clinically and systematically. The results of these inquiries were sent to the editor of the *Edinburgh Medical and Surgical Journal* in 1837 and 1838, and published in it in 1838, 1839. Conjointly, these papers are equal to an octavo volume of more than 200 closely printed pages.

In these essays, Dr Laycock grouped together, as to cause, the phenomena of religious epidemics and "revivals,"* those of "imitation,"† those of mesmerism, and those resulting from various similar causes in different parts of the world.‡ Thus the doctrines and its applications, of which Dr Carpenter claimed merit in 1855, were fully stated and developed by Dr Laycock in 1838.

Nor was this all. It had been observed how much of fraud and falsehood was mixed up with the mesmeric experiments; and as to this point, Dr Laycock demonstrated the influence of the generative glands in exciting impulsive and moral insanity, by developing the automatic action of the cerebrum. By the aid of comparative psychology, he showed the ovarian origin of hysterical cunning, insane fire-raising and theft, infanticide, pica, &c.§ Again; at this time the whole pathology of insanity was in the most confused state; some physicians even doubting whether the brain was concerned in the disease or not. Dr Laycock demonstrated the influence of morbid blood on the brain in developing insanity, and thus established the humoral pathology of the disease, as a disease of the nervous system, on a scientific and practical basis. Further, Dr M. Hall was contending that the law of responsive and adapted action to external stimuli, according to the teleological *lex nostri conservatio*, was limited to the true spinal system, to the exclusion of all parts of the encephalon above the *tubercula quadrigemina*; but Dr Laycock, by demonstrating the morbific influence of colours in inducing spasmodic diseases and morbid appetites, showed that the cerebral nerves proper, or nerves of special sense, were also excitors.[*]

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* Cases quoted from Wesley's Journal, and references to Hecker and others; *Edin. Med. and Surg. Jour.*, April 1838, p. 457.

† *Ibid.* p. 450.

‡ "The Pythian priestess, the wizards of Kamtschatka, the whirling dervises of India, the serpent-eaters of Egypt, the second-sight men of the Highlands, the 'wise men' (μαγοι) and prophets who still may be found in Yorkshire, and the O'Keys, are all or the same family—all knowing how to excite convulsions, or delirium, or spectral illusions and somnambulism, in themselves of their dupes, by mental acts or drugs." (*Ibid.* July 1839, p. 25.)

§ *Edin. Med. and Surg. Jour.*, No. 136, July 1838.

It is quite true that exception may now be taken to various minor details of neurological anatomy contained in Dr Laycock's early papers, for that has made great progress since their date; but the general principles then developed, and their applications then shown, have only been confirmed by every recent discovery in mental physiology. To understand the difficulties he had to encounter in the investigation, regard must be had to the then incomplete condition of metaphysics as well as of neurology, and the entire want of any satisfactory explanation of the relations of the cerebral functions to Thought. No one has more strongly shown these than Dr Carpenter himself; for at the same moment that Dr Laycock was working out his views of the automatic action of the hemispheres, and its analogy in health and disease to the automatic action of the spinal cord and sympathetic ganglia, Dr Carpenter was engaged upon the first edition of his first work on Physiology. It was published in 1839, at the moment when Dr Laycock completed the first publication of his doctrines, and contained a statement of Dr Carpenter's entire ignorance of mental dynamics, or of the method which Dr Laycock had followed in investigating them.[†]

Now, at this time Dr Carpenter had already published his views on the functions of the nervous system in relation to instinctive and voluntary actions,[‡] in which his principal object was to distinguish between muscular movements effected with and without sensation, as a development of Dr M. Hall's views;

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[*] *Edin. Med. and Surg. Jour.*, No. 137, Oct. 1838, p. 349.

[†] "The complexity of the operations of the *mind*, and the impossibility of deriving from the study of the lower animals any assistance which can be relied upon in their analogies, have hitherto been a complete bar to the successful investigation of them as portions of the nervous system. It is yet quite uncertain how far mental acts are dependent on or connected with any changes in its condition; and we only know that they can neither be excited in the first place, nor effect any change upon the material structure of the body, except through its intervention."—*Principles of General and Comparative Physiology*," &c., by Wm. B. Carpenter, Member of the Royal College of Surgeons of London, &c. (Lond. 1839), p. 454.

[‡] "On the Voluntary and Instinctive Actions of Living Beings." *Edin. Med. and Surg. Jour.*, No. 132. July 1837.

to whom and to Dr John Reid he owed his fundamental ideas.*

Dr Carpenter was a follower of Professor Alison, who attributed both the reflex acts and the instinctive actions of lower animals and of man to sensation. While, however, he retained a portion of the Alisonian doctrine, and admitted a class of sensational instincts, he pointed out that there was also a non-sensational class. He showed that certain instinctive acts are due to an impression without sensation (the doctrine of reflex action), and to an impression with sensation, as suggested to him by Dr John Reid. These, however, were both old doctrines, and were not, in fact, made clearer by Dr Carpenter; for he was still under the influence of the Cartesian hypothesis, then all-dominant, as to the identity of consciousness and mind as an agent; so that he made the simple passive state of consciousness of an impression the cause of vital changes.† With such notions, derived from the Cartesian school, as to the causal activity of mere passive states of the consciousness, any clear ideas as to the relations of the brain to thought were simply impossible. Hence the declaration of Dr Carpenter, that cerebral physiology, in its relations to the mental operations, was to him a complete blank. Now, Dr Carpenter has never escaped from this fundamental fallacy; so that in even this latest development of his doctrines he still adheres to the Cartesian notions, and so mixes them up with the doctrine of automatic vital action, that his psychological expositions have the appearance of a motley patchwork of incongruous views.

The German physiologists, being to a certain extent followers of Leibnitz, were less backward than the English in mental physiology. Hence Müller had already clearly developed, in

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* "There has been much controversy amongst physiologists as to the classification of those muscles which, being called into play in the living body by the stimulus of nervous power alone, are more or less under the control of the will. My friend, *Dr John Reid, has suggested to me*, that the difficulty may be overcome by regarding every muscle in the body which is supplied by motor nerves as equally susceptible of stimulation from two different sources—namely, volition, and sensation without volition." (*Op. cit.*, p. 31.)

† "The consciousness of an impression is an act of sensation: and here the purely mental functions commence."—Art. by Dr Carpenter in *Br. and For. Med. Review*, April 1838, in which he re-states the views contained in the paper just referred to.

1838, many of the doctrines which Dr Carpenter had only arrived at as novelties in 1853. But even he was partly under the influence of the Cartesian doctrines as to the nature of consciousness. At this time, no one taught in England the Liebnitzian principles except Sir William Hamilton, who first expounded them in his courses of lectures in the University of Edinburgh, which he began in 1836-7.*

In 1840 Dr Laycock published his *Treatise on the Nervous Diseases of Women.* It was a second edition of his papers on Hysteria, and contained a re-statement of the greater portion of the doctrines they contained. Dr Carpenter reviewed the physiological portion of this work.† It is not surprising that, with his preconceived notions, he could not comprehend Dr Laycock's doctrines, and that, in particular, the chapter‡ which set forth in substance the fundamental correlations of the physical, vital, and mental forces (see *ante,* vol. i. p. 269), was wholly unintelligible to the critic. Of this chapter Dr Carpenter observes, "There is a good deal of vague and pointless allusion to the doctrines taught in the ancient schools of philosophy, mixed up with speculations respecting the molecular actions of matter, which do not seem to lead to any definite end. In fact, we are at a loss to know what our author himself had in view."§ The doctrines as to the influence of voluntary and involuntary *attention,* as a cause of morbid cerebral and mental states, were also imperfectly comprehended and stated. And no reference whatever was made to the *involuntary* acts of attention which are so largely influential in developing mesmeric and similar phenomena. In like manner, the scope of the chapter headed "The Instinctive Actions in Relation to Consciousness—the Brain subject to the Laws of Reflex Action," was wholly overlooked.

The new doctrines which Dr Laycock had developed and applied to pathology having excited little or no attention (mainly, it is probable, in consequence of this adverse criticism in so highly influential a journal), he thought it right, in 1844, to bring them, in a more physiological form, before the medical section of the British Association for the Advancement of Science, which met that year in York. This paper was published in the *British and Foreign Medical Review* for January 1845.* To Dr Laycock's surprise, Dr Carpenter, on reading the paper, hinted a charge of plagiarism against him, for he could see in these views nothing more than an exposition of his own; inasmuch as he considered that to have pointed out the immediate dependence of the class of movements upon sensation, was in effect the same thing as Dr Laycock's law of reflex action.

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* See vol. i. chap. v. of this work.

† *Brit. and For. Med. Review,* July 1841.

‡ "Some Points in the Metaphysics and Physiology of the Nervous System considered," p. 86.

§ *Brit. and For. Med. Review,* July 1841, p. 66.

The publicity thus given to Dr Laycock's doctrines attracted attention to them. Amongst others, the late Mr George Combe applied them to an explanation of the involuntary acts and gestures which characterize the instincts and sentiments. He had corresponded with Dr John Reid as to some points of the anatomy of the brain; and that able physiologist had incidentally expressed the opinion that Dr Laycock's views were erroneous, since it was well understood that the phenomena he attributed to an unconscious functional activity were dependent on sensation. This was precisely the doctrine advocated by Dr Carpenter at Dr Reid's suggestion. Dr Laycock therefore took the opportunity of showing to Mr Combe in what respects his law of reflex action differed from the sensational law, and Dr Reid controverted in his turn Dr Laycock's views. This correspondence was published.†

In that correspondence Dr Laycock further developed his views, and expressly stated, what in fact had been all along the fundamental idea of his doctrines, that all these vital phenomena, whether reaching the consciousness or not, were due to the operation of a general law of design. After illustrating the law of differentiation or evolution of the *lex nostri conservatio*, from the simplest functions upwards, Dr Laycock stated the general teleological conclusion which necessarily followed from the premises.‡ In the same letter, Dr Laycock indicated the law of reflex nutrition and development as the cause of physiognomical characteristics; of particular types of animals; and of the changes which species undergo, first into varieties, then through these into new species.* Dr Laycock premised these statements by the remark, that what he had previously set forth were fragments of a system he was building up, and that he kept back much of his views because he did not wish to develop it prematurely and imperfectly.

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* *On the Reflex Function of the Brain.*

† "Correspondence between George Combe, Esq., Professor Reid, and Dr Laycock, on the Reflex Anatomy and Physiology of the Brain;" the *Lancet* (1845), vol. ii.

‡ "Now the plain and obvious conclusion from all these facts must be stated, however startling. It is this:—*the development, conservation, and reproduction of all organisms, are regulated by an unerring law of design—a law as generally applicable to living matter as the law of gravity to universal matter.* This law must be our guide in ascertaining the relations of the reflex, instinctive, emotional, and voluntary movements" (*Lancet*, vol. ii. (1845), p. 256).

In the following year Dr Carpenter published an able paper "On the Brain and its Physiology," in the form of a critique upon a phrenological work by Dr Noble. In this essay Dr Carpenter gave a more definite form to his doctrine of causal sensations, extending it upwards to the hemispheres, through the so-called sensory ganglia. But so far from developing the doctrine of unconscious cerebral action, he showed that all ideas, to be active, must be associated with sensations or feelings of pleasure or pain, and that these have their seat in the same central axis as the corporeal sensations which he alleged are the causes of the instinctive acts.† On this occasion Dr Carpenter avoided all mention whatever of Dr Laycock's views; yet the paper contained internal evidence that he had read the correspondence just published in the *Lancet.*

In the *British and Foreign Medical Review* for July 1847, Dr Laycock gave a critical review of Unzer's *Erste Gründe einer Physiologie*, a remarkable work on the functions of the nervous system which he had disinterred from the mass of German literature of the last century. This review attracted so much attention, that the Council of the Sydenham Society requested Dr Laycock to translate the original treatise into English, and also a work by Prochaska on the same subject. Dr Laycock's translations were published in 1851.

In 1848 Dr Carpenter became editor of the *British and Foreign Medico-Chirurgical Review*, which was virtually a continuation of Dr Forbes' journal. The views of Unzer and Prochaska had a favourable influence on mental physiology; in particular, they materially modified the opinions of Dr Carpenter, who now repudiated the distinct excito-motory system of Dr M. Hall. Accordingly the January number of the Review for 1850 opened with a paper from his pen, in which he expressed his more advanced views. It is mainly devoted to a further development of the sensori-motor doctrines, but contains no trace whatever of any knowledge of the reflex functions of the brain. In this respect, the old theories are worked up anew.

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* *Lancet*, vol. ii. (1845), p. 258.

† *Brit. and For. Med. Review*, Oct. 1846. p. 516.

In the following year (January 1851), Dr Laycock contributed to the Review a neurological article (No. XII.), in the form of a notice of recent works on diseases of the nervous system. Thinking this a convenient opportunity for once more bringing his cerebral doctrines before the profession, Dr Laycock gave a summary of them, and showed their applicability to the phenomena of sleep, and to pathological states involving the thoughts and will—especially delirium, somnambulism, ecstasy, reverie, catalepsy, &c. To his great regret, Dr Carpenter suppressed, without consultation with him, the whole of that portion of the article which was devoted to his special subject, leaving only an editorial reference to the doctrines of a complimentary character—a hint that they required "amendment"—one or two vague illustrations—and a general summary.* The explanation Dr Carpenter gave for this suppression of Dr Laycock's views was, that they were inconsistent with those expressed in his own article of January 1850, and trenched too closely upon his own subject. As this was the first time that Dr Carpenter had recognised any difference between Dr Laycock's doctrines and his own, it follows that he had certainly had them before him for ten years (*i.e.*, since 1841), without understanding their bearing. At this time Dr Laycock contributed essays to the *Journal of Psychological Medicine*, in which he applied his doctrines to mental physiology and pathology,† so that he was in a position to be indifferent to Dr Carpenter's censorship.

During this time mesmeric phenomena had never ceased to attract the attention of physiologists and physicists. The publication in Germany, in 1845, of Von Reichenbach's researches on the "Od Force," and the accession of Miss Martineau, the late Professor Gregory, and others, to the ranks of the believers in the mystic hypotheses of mesmerism, developed the mesmeric movement anew; and it continually extended in various ways during the subsequent years, until it culminated in electro-biology, table-turning, and spirit-rapping. The first to develop at this time the causes and nature of these morbid mental states on a scientific basis was Mr Braid. This gentleman, in 1842, and again in 1844–1845,* not only proved experimentally what Dr Laycock had demonstrated in 1838—namely, the influence of the corporeal and mental states known as *attention* on the development of these artificially induced diseases of the brain,—but also the extent to which vital changes might be induced thereby, in the functional activity of other organs;—a doctrine already expounded by Sir Henry Holland;† and by Dr Elliotson and Müller, as to the exaltation of ordinary sensations (see *ante*, vol. ii., 841).

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* "Dr Laycock refers the phenomena of dreaming, spectral and other illusions, the *deliria* of mania and insanity, and the peculiar condition termed somnambulism, to the same head; but we must, for the present, content ourselves with this mention of his views." (Dr Carpenter in *Brit. and For. Med.-Chir. Rev.* (as editor), vol. vii. p. 205.)

† Especially in the articles "On Sleep, Dreaming, and Insanity," *Journal of Psychological Medicine*, October 1851; "On some of the Latent Causes of Insanity," April 1854; and on "The Psychology of Monomaniacal Societies and Literature," July 1854.

The years 1850 and 1851 were fertile in mesmeric and electro-biological literature. Edinburgh and Glasgow, in particular, being the seat of much excitement on the subject, important works on both sides of the question emanated from Edinburgh.‡ It was doubtless these phenomena, and the discussions regarding them, which at last opened Dr Carpenter's eyes as to the true meaning of Dr Laycock's doctrines of the reflex function of the brain. Accordingly, in 1851, he invited Dr Laycock to contribute to the Review an essay on the general subject, which was accordingly written.§ While in this essay the physiology and pathology of attention and suggestion were developed by Dr Laycock, according to the principles he had held since he first directed his inquiries to mesmeric phenomena in 1837, he did not omit reference to his views of the close relation between these phenomena and that automatic action which he maintained to be the functional law of the cerebral centres.*

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* *Medical Times*, Dec. 1844, Jan. and Feb. 1845.

† *Medical Notes and Reflections.* 1839.

‡ Amongst others, Dr Alexander Wood wrote a pamphlet on the subject; his general conclusions on this occasion, in regard to the anatomical relations of the phenomena examined, fully anticipated what Dr Carpenter taught in the following year. Thus his eighth and last conclusion runs, "That the cerebral hemispheres can excite the cord to motion independently of the other centres; hence, ideas in the mind may produce motion independently of volition" (p. 28). And in the conclusions in which he differed from Dr Carpenter, the weight of argument is on Dr Wood's side.

§ "Odyle, Mesmerism, and Electro-Biology, &c," *Brit. and For Med.-Chir. Review*, Oct. 1851.

The metropolis did not escape the mesmeric mania, and Dr Carpenter, like others, was busy, while this essay was being written, seeking for an explanation of the facts, which could no longer be denied on the ground of fraud. Starting from his own theories as to excito-motor and "sensori-motor" phenomena, and reflecting on the dominant influence of ideas in mesmeric and other states over the movements of the individual, lately demonstrated by Mr Braid, he denominated all actions so produced "ideo-motor." Seeing how purely automatic they were in their character, and looking about for a general principle to explain this, he now, confessedly for the *first time*, recognised the true meaning of Dr Laycock's doctrine of a reflex function of the cerebrum, considered as the seat of ideas, and as the legitimate expression of the class of movements to which he gave the name of "ideo-motor;" and acknowledged that Dr Laycock had made a real and important advance in carrying out the doctrine of reflex action to that organ. When, therefore, Dr Carpenter delivered a lecture on the subject to the Royal Institution of Great Britain,† his task was an easy one. He had, on the one hand, to apply the doctrines of causation, taught most fully by Sir H. Holland, Mr Braid, Dr Wood, and others, as well as by Dr Laycock; and, on the other, the principles of cerebral dynamics, as propounded by Dr Laycock exclusively,—and his explanation was complete. This in fact, was substantially the course Dr Carpenter took, dwelling mainly upon "Suggestion" as a cause. Consequently, there is not one original idea developed in his paper. The only thing new is the one phrase *ideo-motor*, which, as applied by him to reflex cerebral phenomena, simply means motive. Yet, in some way or other, the public became possessed with the notion, that the whole of the doctrines he taught originated with him—a notion into which Dr Carpenter himself finally lapsed. It does not appear from the printed abstract of the lecture whether Dr Carpenter referred to any other researches than those of Mr Braid ; there is a vague and curt acknowledgment of Dr Laycock's priority as to the "reflex" function, but in a foot-note, a circumstance sufficiently showing that the reference to Dr Laycock was no part of the spoken matter.*

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* "One great fact proper to all is, that the action of the will and of consciousness is suspended, and the encephalic ganglia partially or wholly placed in the condition of the 'true spinal' or reflex system. Dr Alexander Wood refers to this principle in his explanation of the phenomena, and quotes a case adduced by Dr Laycock in proof of his doctrine of cerebral reflex action" (*op. cit.*, p. 425). Again: "As in the system of spinal reflex actions there are the class termed *centric*, so also there are *cerebral* reflex acts of centric origin. These are best seen in cases of *impulsive insanity*, in which a person is hurried by an internal impulse, which he can neither account for nor control, to do various insane acts. Now, a condition exactly analogous is excited in persons affected electro-biologically; the difference is only in the mode in which the impulsive idea is produced. In the one, it is the result of functional disease; in the other, it is suggested to a mind in which the brain is in the condition we have already considered," &c. (*Ibid.*, p. 426.)

† *On the Influence of Suggestion in Modifying and Directing Muscular Movements independently of Volition*; Friday, March 12, 1852.

The number of the *Medico-Chirurgical Review* which contained Dr Laycock's article on Mesmerism had not been published more than a few weeks, when Dr Carpenter informed him that he was preparing a contribution to the *Quarterly Review* upon the same subject. In writing to Dr Laycock as to the reception his article had met with, he asked him how far he had worked out the idea that all the actions of sleep-walkers, somnambulists, hypnotists, electro-biologists, came under the laws of reflex cerebral action, as he intended to refer to his (Dr Laycock's) researches in his forthcoming article in that Review. The information was supplied as requested.

The article thus announced in 1851 by Dr Carpenter, as in preparation for the *Quarterly Review*, did not appear until September 1853, when Dr Laycock's review of Dr Carpenter's chapter on the Functions of the Nervous System had already been published.† The titles of the works which Dr Laycock had noticed in his article of July 1851 headed Dr Carpenter's article, with the addition of his own *Principles of Human Physiology*, Sir H. Holland's *Chapters on Mental Physiology*, and three or four brochures on Table-turning and Spirit-rapping.* There is no reference whatever in this essay to Dr Laycock's views; but, in an attempt to explain certain phenomena of "table-talking," contained in a foot-note (p. 555), the writer (being Dr Carpenter himself) remarks,—"This is only an hypothesis, but it will be found to be in strict conformity with the physiological views *put forth by Dr Carpenter* as to "the *unconscious action of the cerebrum*"—*i.e.*, put forth in his recently published "*Principles*." Dr Carpenter, in explaining this remarkable omission from the article of all reference to Dr Laycock's views, stated that it originally recognised Dr Laycock's services as intended, but that, contrary to his wishes, the editor of the *Quarterly Review* suppressed that portion of the MS.

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* The printed words are—"The *cerebrum* is universally admitted to be the portion of the nervous system which is instrumentally concerned in the formation of ideas, the excitement of the emotions, and the operations of the intellect; and there seems no reason why it should be exempted from the law of 'reflex action,' which applies to every other part of the nervous system." The foot-note appended to this passage says—"To Dr Laycock is due the credit of first extending the doctrine of reflex action to the brain."

† *Medico-Chir. Review*, July 1853.

In the spring of 1852 Dr Carpenter had informed Dr Laycock that he was at work upon this new edition (the fourth) of his *Principles of Human Physiology*, and was elaborating the psychology of it upon the basis of Dr Laycock's law of the reflex function of the brain, having avowedly adopted the idea. Under these circumstances, when, in April 1852, Dr Laycock had the pleasure to receive Dr Carpenter as a guest into his house at York, he afforded Dr Carpenter every facility for the comprehension of his views, both in daily conversation and by placing upon Dr Carpenter's writing-table copies of his papers on the subject.

This fourth edition of the *Principles of Human Physiology* was published in December 1852. The psychology consisted of an expansion of the doctrines contained in the paper read at the Royal Institution in March of the same year; but it also had the same vague character as to the sources from whence the author had drawn his facts and doctrines, and the same covert claim to originality. There was, however, a foot-note in the body of the work which made special reference to one of Dr Laycock's papers, and one only; but no notice of his essay published in October 1851, nor of any of his earlier papers.† This acknowledgment, doubtful as it is in meaning and extent, recognised only a small portion of Dr Laycock's doctrines, and was rendered still more doubtful by a claim to priority, as to even that fragment, which Dr Carpenter set up in the *preface* to his work.*

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* "Electro-Biology and Mesmerism," *Quar. Review*, vol. xciii. p. 80.

† "The application of the doctrine of 'Reflex Action' to the Brain was first fully developed by Dr Laycock of York, in a paper on the Reflex Function of the Brain, read before the medical section of the British Association, at its meeting in York, Sept. 1844, and afterwards published in the *British and Foreign Medical*

Dr Carpenter's belief, thus expressed, as to his own originality in the matter, was doubtless sincere, but it was wholly delusive. In January 1850 he had confessedly no conception whatever of these modes of action of the cerebrum, either in normal or abnormal mental states. It was only in the following year that he recognised, for the first time, Dr Laycock's doctrine of cerebral reflex action, while suppressing an exposition of it in the journal of which he was the sole editor. Now, in the same years (1850, 1851), a vast stride was being made in both the observation of

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Review, vol. xix. Not having recognised what appears to the author the essential distinction, both in their anatomical and physiological relations, between the sensory ganglia and the cerebrum, or hemispherical ganglia, Dr Laycock did not mark out the distinction between the '*sensori*-motor,' or 'consensual actions,' which are the manifestations of the reflex power of the former, and the 'ideo-motor' actions, which depend upon the reflex action of the latter. But, in adopting that part of it which is strictly applicable to the cerebrum, and in applying it to those various states which agree in the common characteristic of the existence of mental activity without volitional control, the author considers that he is merely giving greater definiteness and a wider application to Dr Laycock's doctrine" (p. 799, foot-note).

* "The peculiar states which are known under the descriptions of somnambulism, hypnotism, mesmerism, electro-biology, &c., are all considered in their relations to sleep on the one hand, and to the ordinary condition of mental activity on the other; and the author ventures to believe that he has not only succeeded in throwing considerable light upon the nature of those aberrant forms of physical action, but that he has been enabled to deduce from their phenomena some inferences of great importance in psychological science. He would particularly refer to that portion of section 5 which relates to the *automatic* operations of the mind, and to the relation of the will to those, as opening up what he believes to be an entirely new line of inquiry. It is with great satisfaction that he can refer to his friends Dr Holland and Dr Laycock as participating (with regard to all essential points at least) in his own views on all these subjects; and though all which he has here written upon them *is the expression of the results of his own observation and reflection*, yet he gladly takes this opportunity of acknowledging the great benefit which he has derived from the writings and conversation of these philosophical and independent thinkers" (p. 13).

the phenomena he refers to, and in the explanation of them according to physiological laws; and Dr Laycock had not only summarised the results of the inquiry in July 1851, at Dr Carpenter's particular request, but at the close of 1850 had put Dr Carpenter in a position to know his views as to the automatic action of the brain in delirium, somnambulism, insanity, &c., in transmitting them to him for publication in the *Med.-Chir. Review.* These remarks refer to Dr Laycock's researches only, but it must always be remembered that Sir Henry Holland, Mr Braid, Dr Alexander Wood, and others, had already preceded Dr Carpenter in the inquiry, and that their views were in fact familiar to him; so that the doctrines which he claimed as the result of his own observation and reflection were really the results of the observation and reflection of others, already published, and of which he must have had a full knowledge.

Dr Laycock was exceedingly reluctant to interrupt the cordial relations existing between Dr Carpenter and him, by reclaiming against the claim of priority Dr Carpenter had set up. It was very satisfactory to him to find that at last his doctrines had found recognition, however imperfect, in so important a volume as the "*Principles*:" with all its faults, the exposition of them was a lucid and satisfactory explanation of many points in mental physiology, as compared with the useless doctrines current; and he was not without a hope that Dr Carpenter would discover he was mistaken in his claim to originality. Besides, all the more important metaphysical questions connected with Dr Laycock's principles (of which Dr Carpenter manifestly knew nothing) had yet to be brought into correlation with physiological laws (as has been attempted in this work); so that it seemed to him to be unnecessary to make any formal reclamation. He therefore took the opportunity of simply affirming his own doctrines,* without special reference to Dr Carpenter's claim to priority, with the conviction that Dr Carpenter's sense of justice would lead him right. Dr Carpenter saw this statement, and understood its import; but, unfortunately, he was already fully possessed by the idea that he was not only the discoverer of the entire doctrine of unconscious cerebral action, but was also the first to apply it to mental physiology and pathology. He therefore, in the spring of 1855, not only again put forth an unqualified claim to priority in the preface to the *fifth* edition of his *Principles of Human Physiology,* but omitted, at the same time, that acknowledgment of the assistance he had derived from Dr Laycock inserted in the preface to his fourth edition. Under these circumstances, Dr Laycock thought it necessary to at once call Dr Carpenter's special attention, through a mutual friend, to the unfounded and unjust character of his claim. On this occasion Dr Laycock made no reference whatever to the numerous opportunities, both private and public, which he had afforded Dr Carpenter for becoming acquainted with his views during the previous ten years, but restricted the terms of his reclamation to the *Essay on the Reflex Function of the Brain,* published in 1845; the only one quoted by Dr Carpenter himself. Dr Carpenter received the reclamation in the same friendly spirit with which it was made; and, after a due consideration of facts, professed himself convinced that Dr Laycock's claim to priority was well founded, although he felt that he had arrived at his conclusions by a process of independent thinking. He therefore fully acknowledged, that not only the doctrine of cerebral unconscious (or reflex) action was due to Dr Laycock (which he had already fully conceded), but also its applications to insanity, dreaming, delirium, somnambulism, hypnotism, electro-biology, reverie, &c.; and in accordance with these convictions, he expressed, in a written communication, his intention to withdraw the claim of having been the first to formularize the doctrines, in the next edition of his work.

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* *Jour. of Psychol. Medicine*, Oct. 1854.

Five years have now elapsed since the expression of that intention, but no new edition of Dr Carpenter's valuable work has been called for, and no withdrawal of the claim has been made; so that during the whole of that period Dr Carpenter (so far as Dr Laycock knows) has allowed himself to be considered as the discoverer of this important law of cerebral physiology, without at any time intimating how much of it was due to another. It is therefore under these circumstances that Dr Laycock has thought it right to set forth the origin and progress of the doctrines expounded in this work, and to show that in not recognising Dr Carpenter's claims, he has done that able writer no injustice.

THE END.

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